Weatherwise

Volume 11, Number 2 April 1958

"SOME PEOPLE ARE WEATHERWISE BUT MOST ARE OTHERWISE"—BENJAMIN FRANKLIN

WEATHERWISE

THE MAGAZINE ABOUT WEATHER

DAVID M. LUDLUM, *Editor* HENRY W. BULKLEY, *Associate Editor*

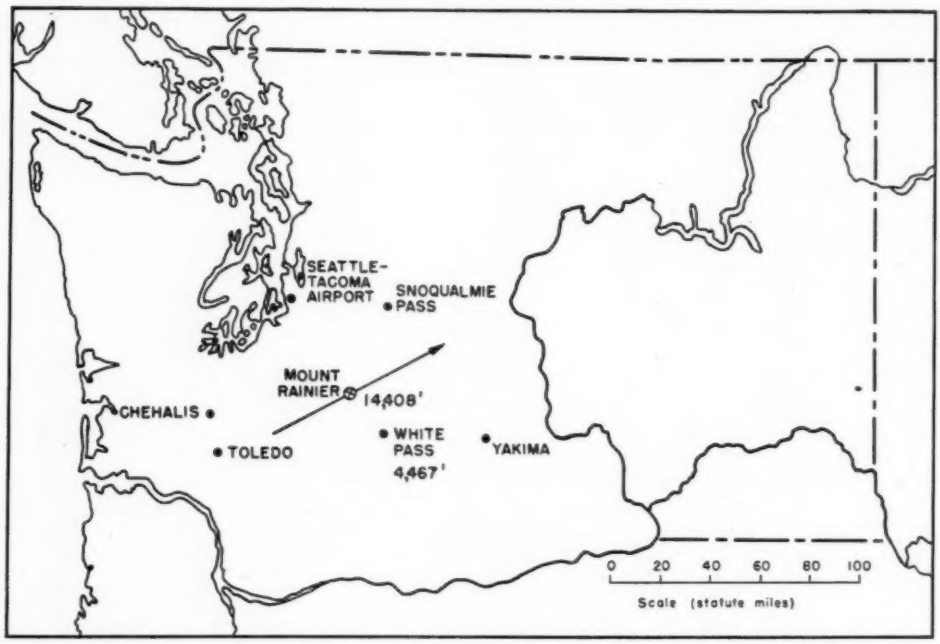

FIG. 1. A map of the State of Washington shows the pertinent locations in the vicinity of Mount Rainier depicted on the front cover. Wind arrow shows prevailing wind direction at occurrence of cloud form outlined on opposite page.

Vol. 11, No. 2 April 1958

CONTENTS

Flying Saucers over Mount Rainier
— Richard J. Reed 43

An Air Force Weather System
— George A. Guy 46

Forecasting Tornado Possibilities
— Alexander Sadowski 51

Snowfall in Florida
— David M. Ludlum 55

Weather Rambles
— Ivan Brunk 56

Florida's Winter Weather: 1957–58
— Keith Butson 58

Research and Education in Meteorology
— Committee on Meteorology, NRC 60

Weatherwatch 68

Front cover: The scene to the northeast of Mt. Rainier late on the afternoon of 29 December 1956 as caught by the camera of Josef Scaylea of the Seattle *Times*.

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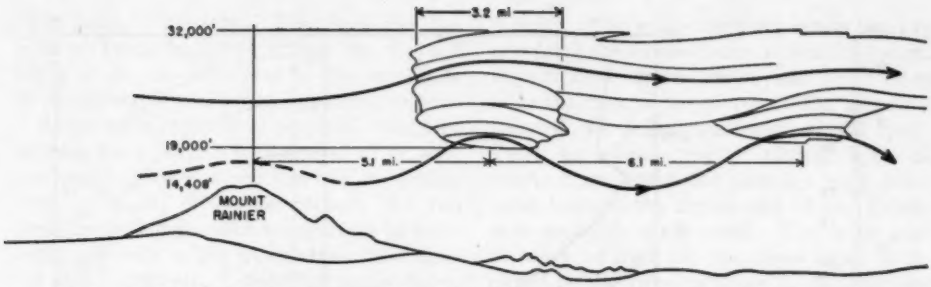


FIG. 2. Outline of cloud and topography. Heavy lines with arrows show probable air motion. Dashed portion of lower line are less certain.

Flying Saucers over Mount Rainier

RICHARD J. REED, *University of Washington*

ON the afternoon of 29 December 1956 Josef Scaylea, photographer for the Seattle *Times*, was atop Pigtail Peak near White Pass, Washington, taking ski pictures for the rotogravure section of the Sunday *Times*. As he went about his work, little did he suspect that by nightfall he would have captured a cloud picture of rare beauty and perhaps shed new light on the mystery of the flying saucers.

It had been a wonderful day for the throng of weekend skiers gathered on the slopes of Pigtail Peak, more like a day in early spring than in late December. While down in the pass temperatures hovered near freezing, the slopes were bathed in warm sunshine which filtered down through thin cirrus clouds and lifted temperatures to a balmy 50°. But the most memorable event of the day was not to occur until late afternoon. Just as dusk began to settle a murmur of excitement rippled through the crowd. Off towards the northeast horizon a strange, saucer-like object had suddenly appeared in the sky. Several of the skiers urged Mr. Scaylea to take a picture of the object. However, it was still quite distant and somewhat ill-defined so he deferred.

During the next few minutes, the object moved rapidly toward Mount Rainier and began to sharpen in outline. Meanwhile Mr. Scaylea had boarded the chair lift to descend to the pass. By the time the lift had travelled a short distance, the phenomenon had reached a state of breath-taking beauty, and it was then that Mr. Scaylea snapped the picture which appears on the cover. Although viewers on the hill likened the object to a saucer, a telephone appears to be a more apt description at the time of the photo.

OROGRAPHIC CLOUDS

The saucer-like object which caught the attention of Mr. Scaylea and the skiers was, of course, not a vehicle from outer space, but a unique type of orographic cloud. When air flows over hilly or mountainous terrain, an up-and-down wave motion may be impressed upon it, provided that temperature and wind conditions are proper. As the air describes its wave-like path it alternately warms and cools, the warming taking place as it sinks into the wave trough and the cooling as it ascends to the wave crest. If the air is very dry, the undulating current will not be visible to the eye, though the updrafts and downdrafts will readily be felt by aircraft which chance to pass through them. On the other hand, if the air before entering the wave is sufficiently moist, the cooling in the wave crest will cause water droplets to condense and cloud to appear.

In the vicinity of an isolated peak, the cloud may assume the form of a cap covering the summit or it may be displaced slightly down-wind and resemble a lens or disc. Not infrequently a series of lenticular clouds will be observed trailing down-wind at regular intervals of a few miles.

Because of its connection with the underlying terrain, an orographic cloud generally remains stationary or nearly so, even though the wind may be streaming rapidly through

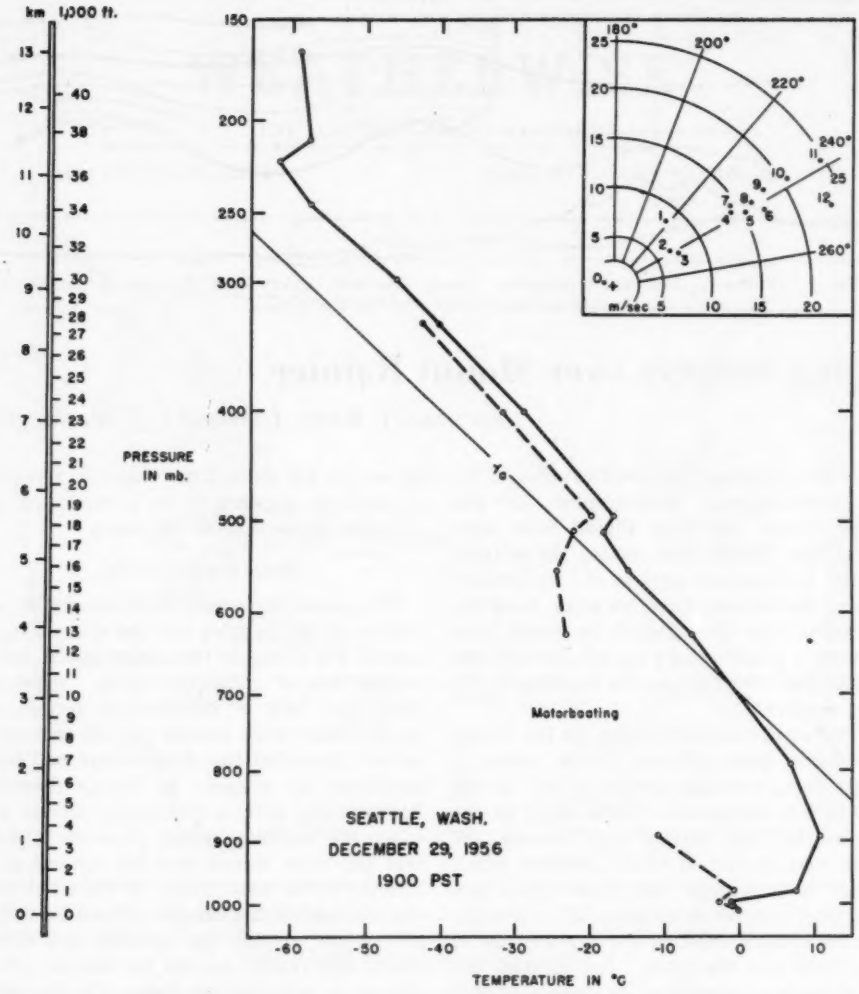


FIG. 3. Sounding and hodograph (inset) for Seattle 29 December 1956. Sounding: solid line—temperature, dashed line—humidity, 1900 PST. Hodograph: points labelled in kilometers, winds in meters per sec., average of 1300 and 1900 PST.

it. There are, however, notable exceptions to this rule, as we shall see later when we discuss the matter of flying saucers.

THE "TELEPHONE" CLOUD DETAILS

First let us take a closer look at the "telephone" cloud photographed by Mr. Scaylea. The reader who is interested in more general facts and theories concerning orographic clouds and lee waves is referred to the International Cloud Atlas (1) and to a recent review article by Corby (2). The main features and dimensions of the cloud are shown in figure 2. Mount Rainier, White Pass, and other pertinent locations are marked in figure 1.

It is seen from figure 2 that the first visible wave crest or "pile of saucers" was situated about five miles from the summit of Mount Rainier (14,408 feet) and that the second was approximately six miles farther downstream. The discs themselves are roughly

three miles in diameter. They give the illusion of being in rotation, but the circular shape is due to variations in the amplitude of the air waves and not to a spinning motion.

A distinct layering may be noted. The lobe nearest the mountain is composed of at least five strata, three of which join with the second lobe. The bar or handle between the two lobes can be attributed to a decrease in wave amplitude with height so that the cloud does not sink sufficiently to dissolve in the interstice. The base of the cloud is at 19,000 ft., the top at 32,000 ft.

The foregoing figures were obtained with the help of a detailed map of the area, a measuring rule, and some elementary trigonometry. Because of the large number of identifiable peaks in the photo, it is believed that the figures are highly accurate. The following incident will perhaps substantiate this claim better than a rigorous scientific analysis.

When the facts relating to the picture were first discussed with Mr. Scaylea, he said that the photograph was taken from the platform at the top of the chair lift. In making the measurements it was noted that it was impossible to join various points in the background and foreground and have them converge to the summit of Pigtail Peak. They met instead at a point on the ski lift at about a quarter of a mile below the summit. This discrepancy so troubled the writer that he made a special trip to White Pass armed with the picture. The lift was operating at an accelerated speed and only skiers were permitted to use it, but thanks to the courtesy of Jim Sullivan, manager of the ski lift, a special dispensation was granted and the writer was allowed to ride to the summit. Upon arriving there it was immediately apparent that the picture was not taken from the platform at the top as Mr. Scaylea had stated, and on the return trip it was agreed by both the writer and Mr. Sullivan that a point about a quarter mile down the slope afforded a view closely resembling the photograph. When informed of these facts, Mr. Scaylea was slightly taken aback, but upon refreshing his memory, he recalled with certainty that he had indeed not taken the shot until part way down the slope.

In order to make the cloud measurements, it was necessary to assume that the cloud was located directly downwind from Mount Rainier. The wind direction was obtained by averaging the rawins taken at Seattle-Tacoma airport three hours before and three hours after the time of the picture. The airport is situated 45 miles northwest of the peak. From an examination of plotted upper-air charts it was concluded that any wind differences between the airport and Mount Rainier were probably quite small. The mean wind direction of 240° in the cloud layer is depicted by the arrow in figure 1. The detailed hodograph is shown in the inset in figure 3.

From the temperature and humidity sounding in figure 3 it is possible to get an independent check on the height of the cloud base. This is done by determining the lifting condensation level for the various points on the sounding. Most of the lower part of the sounding was characterized by a condition known as "motorboating" which signifies that the humidity was too low to be measured by the radiosonde equipment. Consequently, an exact figure for the lifting condensation level cannot be determined for the lower levels, but it is safe to assume that it is well above 20,000 ft. Above 13,000 ft. the moisture increases and at 18,000 ft. becomes relatively high. All points between these levels yield a lifting condensation level or cloud base of 19,000 ft. in confirmation of the figure obtained by the photogrammetric method.

From a consideration of the foregoing data and examination of the synoptic charts for the period, we arrive at the following picture of the events leading up to the cloud formation. For several days prior to the occurrence a large anticyclone, characterized by subsiding air currents, had settled over the area. At the time of the occurrence a weak storm was approaching the Washington coast from the Pacific Ocean, and stations along the coast were reporting cirrus lowering to altostratus and altocumulus. In the area about Mount Rainier the picture shows mainly cirrus or cirrostratus, while the nearby sounding reveals that a moist layer is drifting in at 18,000 ft.

The wind direction above the peak is nearly constant with height; the wind speed increases only slightly and is not large, averaging about 35 knots. The lapse rate above the ground inversion is relatively unstable. Evidently these conditions were suitable for the forma-

(Continued on page 65)

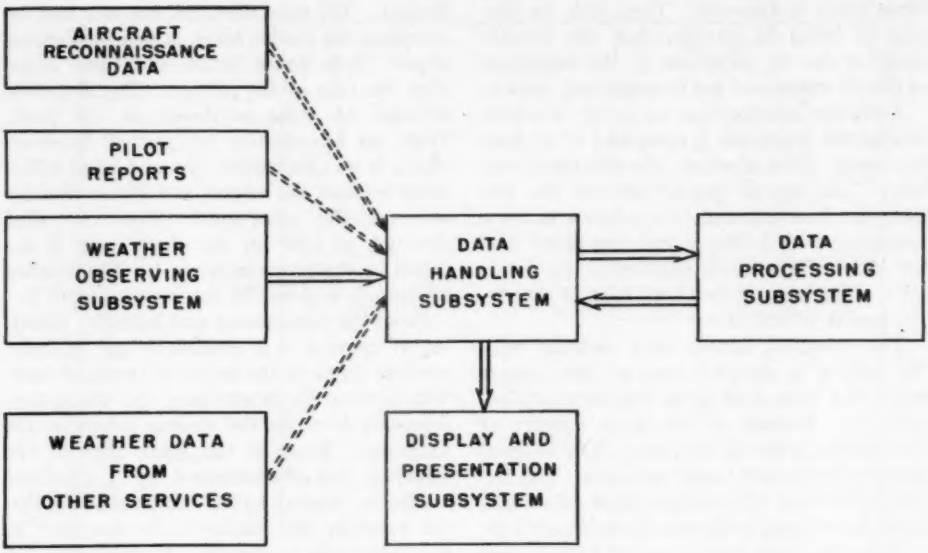


FIG. 1. System 433L flow diagram.

An Air Force Weather System

LT. COLONEL GEORGE A. GUY,
Air Force Cambridge Research Center

A MAJOR overhaul of the weather support to the Air Force is essential to meet the weather requirements of today's operations. With the increase in aircraft speeds and the resulting decrease in mission times, weather information has become a very perishable commodity. The large amounts of weather data necessary to support global Air Force operations have overcrowded the communication circuits, and overburdened the weather stations and forecast centrals.

The procedures for observing, transmitting, processing, and displaying weather information are largely manual and have changed little over the years. Mere modifications of the existing methods are not enough. What is required is an integrated system approach to the weather problem, an approach which will exploit to the maximum the available technology in data handling, data processing, and communications.

On 15 December 1957, scientists of the Geophysics Research Directorate of the Air Force Cambridge Research Center completed a design study for a new Weather Observing and Forecasting System, designated System No. 433L. Although this system is designed for operational use by Air Weather Service, many of its components are suitable for joint operations with other military and civilian weather services.

DESCRIPTION OF THE SYSTEM

The Weather System can be described as a semi-automatic data processing system with the flow of information as shown in figure 1. The observing subsystem includes equipment for the airfield observations, for upper-air or rawinsonde observations, and for weather detection by radar. The data handling subsystem includes the communication networks and the equipments for the collection and dissemination of weather information. The data processing subsystem translates raw observations into useful weather information, and includes both weather analysis and forecasting.

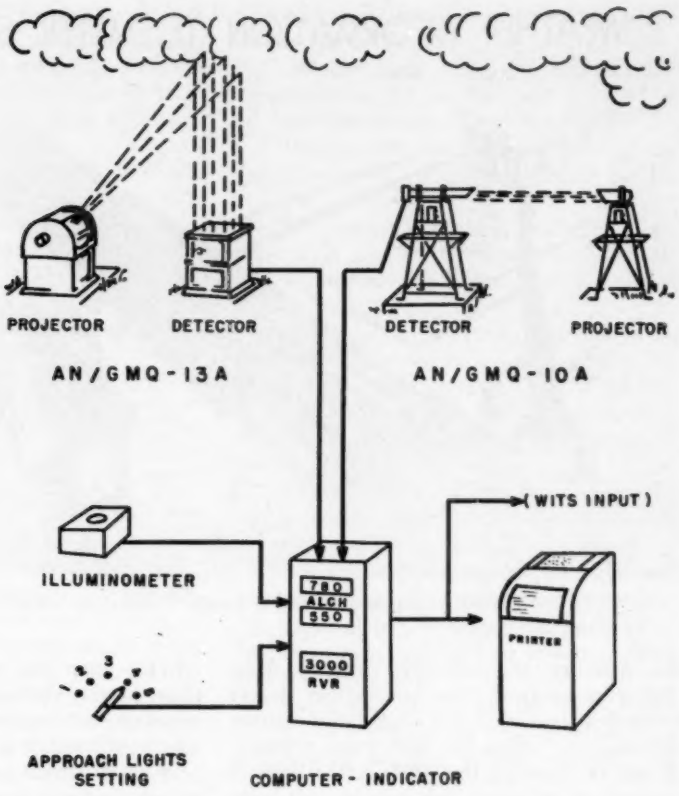


FIG. 2. Approach visibility configuration.

Display and presentation is an important function since the system must satisfy its customer, the weather user.

DATA HANDLING SUBSYSTEM

The present inadequacy of existing teletype networks is generally recognized and this problem has been given considerable study in recent years. The proposed solution is a high-speed network which will utilize 3,000-cycle telephone voice circuits and will have a transmission capability of 1,000 words per minute. All stations in the United States will be connected into a single network which will replace all existing teletype networks. A master control station will control all entry into the network by selectively calling each station, in turn, for transmission into the network.

In the past, a major problem in implementing a network of this type has been the lack of a suitable high-speed printer to replace the teletype. This has been solved through the development of an electrographic printer. This printer records by an electrographic process, has complete electronic circuitry, and the only moving parts will be in the paper feed mechanism.

For entry of weather data into the network, commercial equipment is currently available which operates like a teletype tape transmitter. Since many weather messages such as the hourly observation are fixed-format, single-line messages, a semi-automatic telecode transmitter has been developed for this type of transmission. The weather message is inserted by the observer on visual dials and, upon interrogation by the master station, the telecode transmitter transmits the complete weather message.

With the introduction of a high-speed network, we can expect a significant increase in

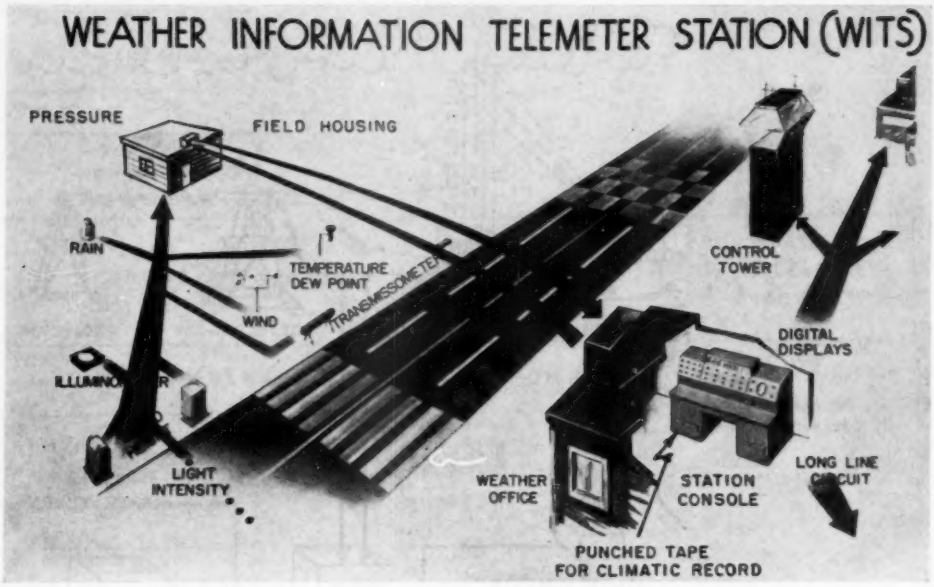


FIG. 3. Component layout of weather information telemeter station.

the quantity of transmitted weather data. Yet, even today the average weather station receives a large amount of superfluous weather information. With the high-speed network, it will be essential that each station have a method of selecting and printing out only that weather information required for its specific operations. In addition, the local station must have a capability for changing its selection as operational requirements change. A Selective Information Filter Terminal is being developed to meet this requirement, and it will be inserted between the high-speed circuit and the printer. The filter terminal will be adjusted to select and print out only those observations required by the local station.

WEATHER OBSERVING SUBSYSTEM

A complete overhaul of the airfield observational equipment is essential to meet the operational requirements of the jet aircraft age. One of the major problems of today is obtaining adequate weather information for aircraft landings. Under a joint Air Force-Weather Bureau project at Newark Airport in New Jersey, techniques have been developed for obtaining Approach Light Contact Height (ALCH) and Runway Visual Range (RVR) from the weather observations of cloud height, visibility, and background illumination. A computer is being developed which will provide this information automatically on a current basis. A configuration of the required equipments is shown in figure 3.

The Weather Information Telemeter Station (WITS) is being developed for semi-automation of the complete airfield observation, and will incorporate all components of the approach visibility configuration. The component layout of the WITS equipment is shown in figure 3. All observational equipment will feed into a Field Housing Unit which will transmit a complete observation every minute to the weather station over a radio link or land line. Since only a single line is required, costly cable installations between the observational site and the weather station will be eliminated. At the Station Console, the weather observer will insert the non-automatic type of observation such as total cloud cover into the message. An observation will be transmitted each minute over a telephone line for visual display in the control tower and at other required locations on the airfield. The complete observation will also be automatically transmitted into

the high-speed network, upon interrogation by the master control station. Climatic data will also be prepared automatically for mailing to the climatic records units.

Rawin Set AN/GMD-2 is being developed to provide upper-air soundings. It will utilize the basic tracking equipment of Rawin Set AN/GMD-1, currently in operational use, but will add a slant-ranging technique which will provide far more accurate wind information. In addition to the slant-ranging components, Rawin Set AN/GMD-2 has provision for automatic computation of both the wind and radiosonde data. New radiosondes and sounding balloons are also being developed in order to provide routine soundings to altitudes in excess of 100,000 feet. These new types of equipment are shown in figure 4.

Data Processing Subsystem

This is really the heart of the system for it is here that we convert raw data into useful weather information. Consider the problem for a minute. The military value of weather information arises from its importance in the formulation of operating and planning decisions, and in the execution of these decisions. Its value is dependent upon many factors such as the speed and timeliness with which it is received, its accuracy and operational suitability, and the confidence which operating personnel attach to it.

In establishing a development program for the Data Processing Subsystem, major emphasis has been given to the problem of translating the technical advances of meteorology into useful operating procedures for the field personnel. This is an area which requires increased emphasis. The principal objectives of an adequate Data Processing Subsystem can be stated as follows:

1. Increased centralization of data processing and forecasting functions is essential with the ever-increasing operational requirements and the decreasing number of skilled forecasters.

2. With centralization, automation of many of the data processing and forecasting functions is both possible and necessary. We would gain little by merely moving the manual procedures of the local station into a central. With the advent of the high-speed data network, we must exploit the newest data processing methods or the centrals will become the bottlenecks.

3. Efficient data processing and weather forecasting require the blending of man and machine into a smoothly working unit.

4. Weather information provided by the system must be operationally useful for the military operations.

5. The system must have flexibility to accommodate both the changing operational requirements and the advances in forecasting technology.

The first major step to be undertaken under the Data Processing Subsystem is the establishment of an adequate test and simulation facility which will utilize a high-speed computer as its basic tool. The functions of this facility will be as follows:

1. Undertaking systematic test and evaluation of specific techniques for processing data and preparing forecasts.

2. Testing the comparative accuracy and operational suitability of various techniques.

3. Determining, through simulated tests, the role of man and machine in a centralized data processing unit.

4. Simulating actual weather support operations to determine the most effective ways of providing mission weather support, and

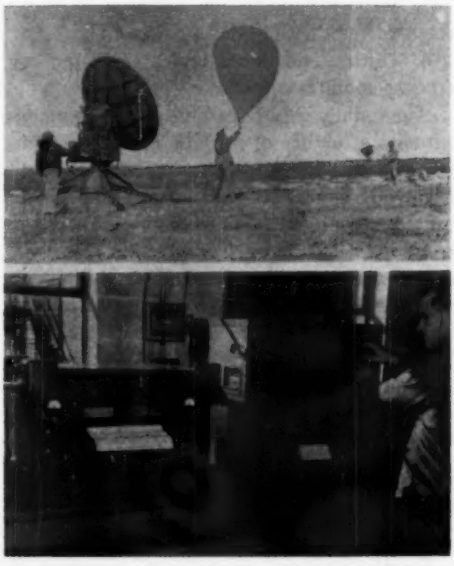


Fig. 4. Rawin set AN/GMD-2.

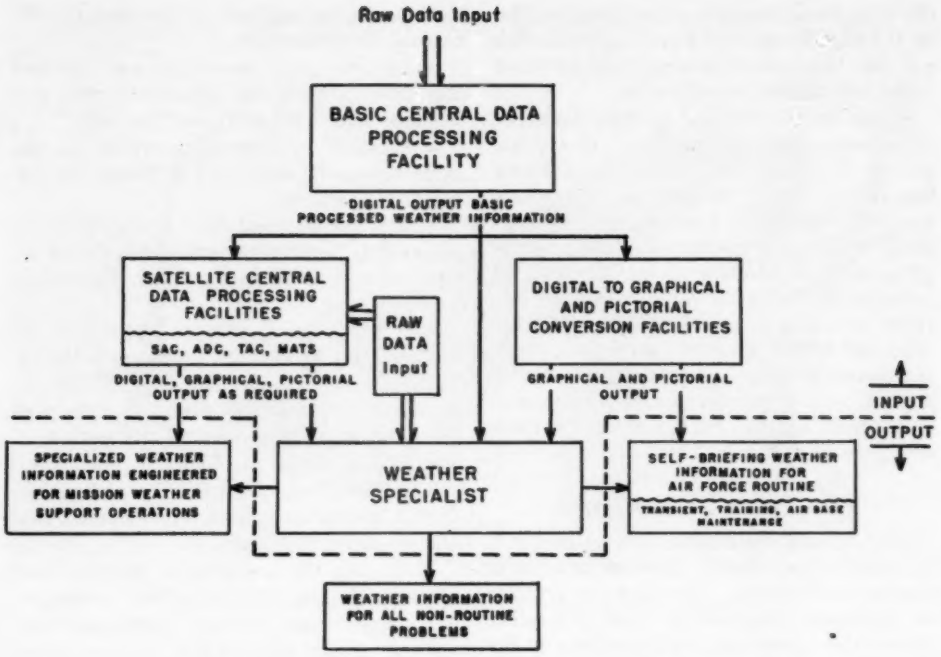

Raw Data Input
BASIC CENTRAL DATA PROCESSING FACILITY
DIGITAL OUTPUT BASIC PROCESSED WEATHER INFORMATION
SATELLITE CENTRAL DATA PROCESSING FACILITIES
SAC, ADC, TAC, MATS
RAW DATA Input
DIGITAL TO GRAPHICAL AND PICTORIAL CONVERSION FACILITIES
DIGITAL, GRAPHICAL, PICTORIAL OUTPUT AS REQUIRED
GRAPHICAL AND PICTORIAL OUTPUT
INPUT
OUTPUT
SPECIALIZED WEATHER INFORMATION ENGINEERED FOR MISSION WEATHER SUPPORT OPERATIONS
WEATHER SPECIALIST
SELF-BRIEFING WEATHER INFORMATION FOR AIR FORCE ROUTINE
TRANSIENT, TRAINING, AIR BASE MAINTENANCE
WEATHER INFORMATION FOR ALL NON-ROUTINE PROBLEMS

FIG. 5. Possible functional organization of data processing system.

determining the operational suitability of procedures developed under the system.

5. Preparing and testing computer programs required for the field units.

6. Testing techniques under simulated operating conditions.

Some study has been given to the organizational structure of a Data Processing Subsystem, but a considerable amount of additional development and engineering is required before any definite configuration can be adopted. In figure 5, a possible functional organization of the subsystem is shown. It is worthy of note that the weather specialist, or weather forecaster, will play a key role. To a large extent, he is the major element of flexibility in the system, exercising judgment and making decisions which are beyond the capabilities of a machine.

Display and Presentation Subsystem

The major development under this subsystem will be the construction of self-briefing facilities which can be utilized for most routine flying operations. An important consideration in this development is that emphasis must be placed on providing weather information in the language of the pilot.

Conclusion

With the scope of this paper, only the highlights of the proposed development program under System 433L have been presented. The overall development program is a systematic exploitation and integration of available techniques and equipments into a true weather system, specifically designed for present and foreseeable military operational weather requirement.

Acknowledgment

The preparation of the System 433L Design Study which is described in this paper was a team effort. The other major contributors to the design study were Dr. Robert M. White, Mr. Robert F. Myers, and Dr. Fred W. Ward, all of the Air Force Cambridge Research Center.

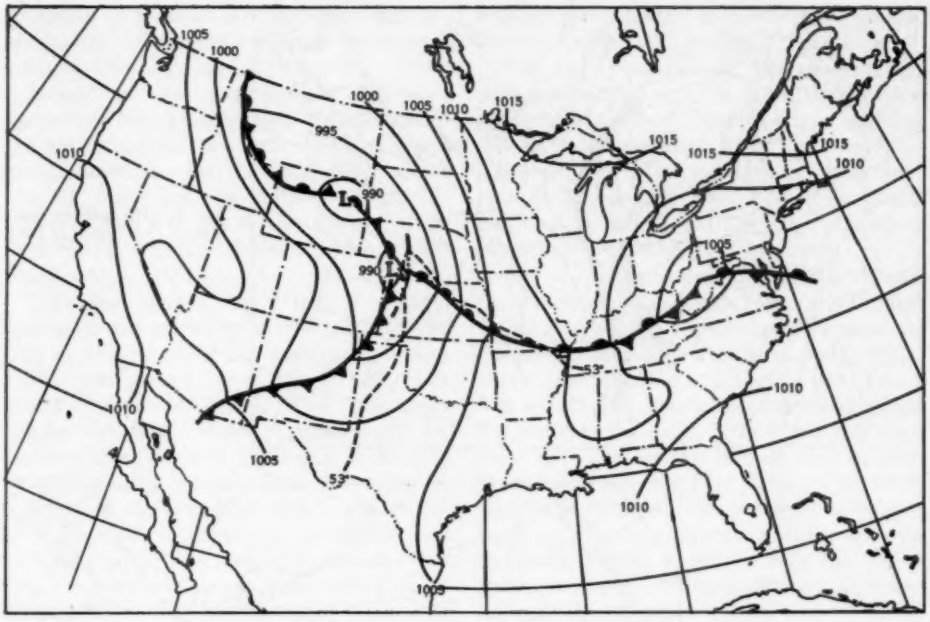


FIG. 1. Simplified surface chart—0630 CST, 20 May 1957.

Forecasting Tornado Possibilities

ALEXANDER SADOWSKI, *U. S. Weather Bureau, Washington, D. C.*

(In collaboration with staff of Severe Local Storm Forecast Center, Kansas City)

MANY people ask, "How does the Weather Bureau prepare a forecast to let us know that tornadoes are possible?"

This question can best be answered by describing briefly some of the work of a weather forecaster on a day when a tornado forecast is issued, and by reproducing a few of the weather charts studied when a forecast is issued to the public.

The principal tornado forecasters are located in the Weather Bureau's Severe Local Storm Forecast Center at Kansas City, Missouri. Early in the morning of 20 May 1957, the meteorologist's first look at the surface weather chart (fig. 1) alerted him to the possibility of a tornado threat later in the day. The following significant features were noted:

(a) The low pressure center was moving eastward at a moderate rate of speed;

(b) Significant atmospheric pressure falls had occurred ahead of the eastward-moving low pressure center;

(c) The cold front along the leading edge of the maritime polar air mass was located in a pressure trough and was moving eastward;

(d) The air ahead of the cold front was warm and moist (with high dew points) and was being carried northward by strong southerly winds; and

(e) The first of what appeared to be the

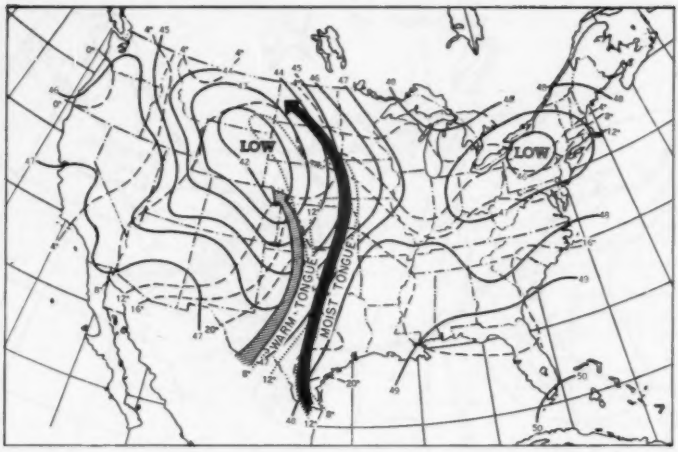


FIG. 2. 850-millibar chart —0900 CST, 20 May 1957.

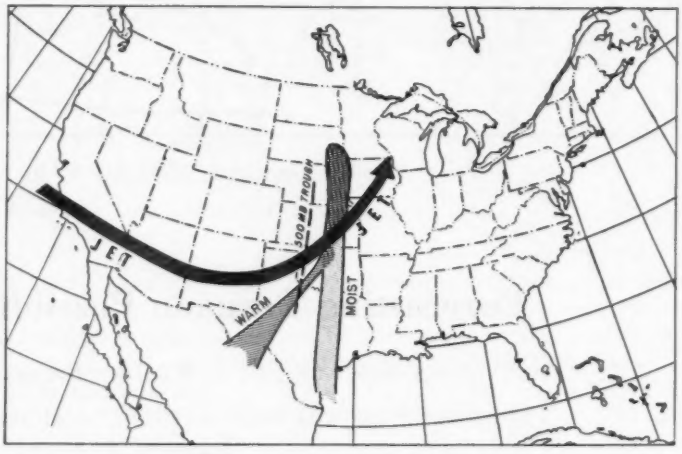


FIG. 3. 500-millibar chart —0900 CST, 20 May 1957.

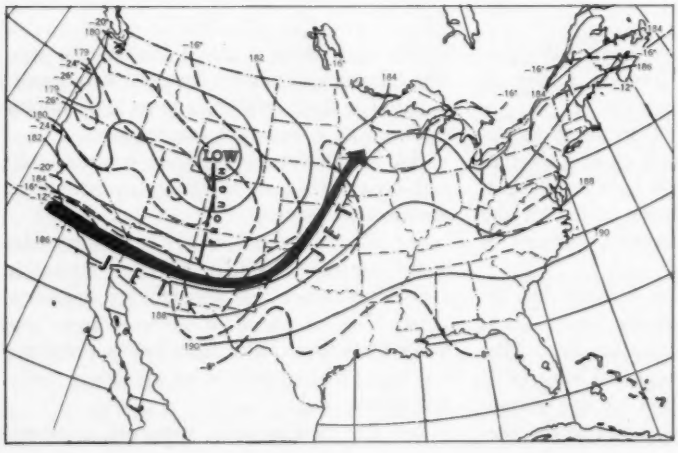


FIG. 4. Prognostic composite chart of tornado potential factors.

beginning of a series of squall lines was approximately one hundred miles to the east of, and parallel to, the cold front.

Alerted to the possibility of tornadoes somewhere over a broad area, the meteorologist next turned to the charts showing the upper-air currents. On the 850-millibar chart (fig. 2), which shows conditions at approximately 5,000 feet above the surface, there were several important features which spelled out danger.

This chart showed that a tongue of moisture-laden air, extending northward from the Gulf of Mexico under the influence of strong winds, was present from the ground to a height of about 5,000 feet. This tongue was moving eastward. Warm, relatively dry air extended from the arid Southwest in currents roughly parallel to and about 100 miles to the west of the tongue of moisture-laden air from the Gulf. A significant indication and warning sign to the forecaster was the fact that the warm-air tongue was moving in an eastward direction more rapidly than the moist-air tongue.

The meteorologist then performed several calculations based on meteorological formulae and estimated that the warm tongue would overtake the moist tongue over southern Nebraska and northern Kansas.

Next, the forecaster examined the chart for the 500-millibar level (fig. 3) which represents conditions at about 18,000 feet above the surface. Here he noted two conditions that could contribute to the tornado-forming possibilities indicated on the other charts:

(a) A trough in the 500-millibar surface extended from Wyoming southward into New Mexico, and

(b) A narrow band of strong winds was flowing from the southwestern part of the United States to the north-central states.

From his experience, the meteorologist knew that a trough in the 500-millibar surface is generally found to the west of an area when it is threatened by tornadoes. He also knew that part of the narrow band of strong winds (sometimes referred to as a Jet Stream) can contribute toward the release of energy associated with tornado development.

More calculations showed that the trough and the band of strong winds would be so situated as to strengthen the possibility of tornado development in southern Nebraska, eastern Kansas and western Missouri.

The next procedure of the meteorologist was to combine on one chart the forecast conditions for the 850-millibar level and the 500-millibar level (fig. 4.) This step also confirmed the suspicion that an area centered in Kansas and extending northward and eastward would be part of the area where tornadoes were likely that afternoon.

The meteorologist examined closely the upper-air soundings at North Platte and Omaha, Nebraska; Topeka and Dodge City, Kansas; Columbia, Missouri; Oklahoma City, Oklahoma; and Amarillo and Fort Worth, Texas. The sounding at Topeka, Kansas, showed that the depth of the moist layer of air had risen from 2,000 feet on the 19th of May to more than 8,000 feet on May 20th. The other soundings disclosed the presence of a very rapid drop in the temperature of the air with increasing height, especially near the top of the moist layer. This condition, the meteorologist knew, could further contribute to the sudden release of energy associated with the development of tornadoes.

After examining these charts and other supplementary charts, the meteorologist was satisfied that his forecast of developments pointed to the threat of tornadic activity in the area of northern Kansas and southern Nebraska, spreading eastward into eastern Kansas and western Missouri. The next problem confronting him was to keep the forecast area for that afternoon as small as possible and yet include the places where tornadoes might occur. He must avoid alerting people unnecessarily and yet alert those who would be in the most dangerous area.

Taking all these factors into consideration, the meteorologist issued a forecast at 1100 CST for tornadoes to occur in the area near a line from Grand Island, Nebraska, to St. Joseph, Missouri (fig. 5), for that afternoon from 1300 to 1900 CST. This forecast was distributed to reach the public in and near the threatened area using all available communication channels, including commercial radio and television stations.

Now the time for rapid detective work had arrived, aimed toward "keeping on top" of a potentially serious situation. Charts were plotted continuously to observe as precisely

FIG. 5. First forecast of possible tornadoes.

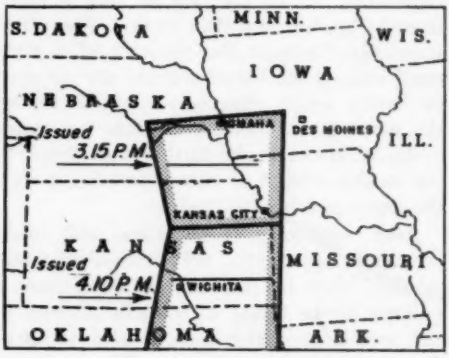


FIG. 6. Extensions of first tornado forecast.

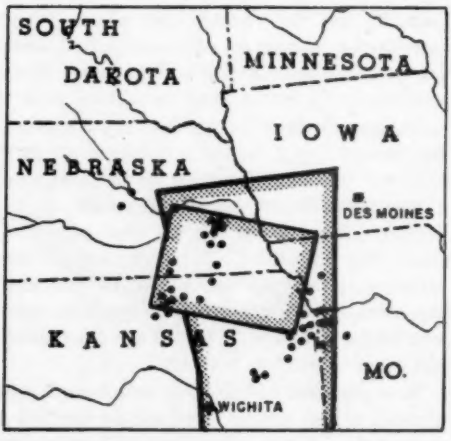


FIG. 7. Tornado occurrences and forecast areas—20 May 1957.

as possible what conditions were actually developing and to determine any changes necessary in the original forecast. Reports from all stations were watched closely. The first confirmation that the forecast was materializing was indicated by radar reports from western Kansas. At 1230 CST radar echoes revealed the presence of a line of thunderstorm activity developing in central Nebraska and central Kansas and a second area in eastern Colorado. The first line increased in intensity and at 1330 to 1345 CST reports began to come in on the sighting of tornadoes near Concordia, Kansas. Relatively little damage was caused by the tornadoes near this portion of the forecast area, as the storms did not strike populated centers.

Continuing the close watch on the situation, the meteorologist issued forecasts between 1515 and 1610 extending the area of expected tornado activity farther into eastern Kansas and western Missouri (fig. 6). These forecasts were distributed rapidly to reach as many people as possible in the areas threatened.

Numerous tornadoes were reported and at 1815 a tornado was spotted at Williamsburg, Kansas, southwest of Kansas City, Missouri. The storm was tracked by radar along its entire path and was also reported by volunteer tornado observers. This information was immediately relayed to radio and television stations to keep the public fully informed so that safety precautions could be taken. The tornado passed through several heavily populated areas before it dissipated about 2000, but not before thirty-three persons had been killed, many injured and millions of dollars of damage done, particularly in the Ruskin Heights section of Kansas City. Figure 7 shows the forecast areas and the resulting tornadoes on May 20th.

By late evening, the contrasting air masses had moved sufficiently to change the characteristic features of the atmosphere that breed tornadoes. The weather charts indicated no further forecasts were needed. Subsequently, no additional storms occurred. It was another nerveracking day in the life of a forecaster.

During the entire year, the Weather Bureau is on duty, day and night, to detect any threat of severe local storms and to alert the public.

Snowfall in Florida

DAVID M. LUDLUM

A FALL of snow at sea level south of 30° N can occur at only three or four locations around the northern hemisphere. It requires a special combination of geographic exposure at the periphery of a large continental land mass and also the presence at the propitious moment of both polar air and an adequate supply of moisture.

The peninsula of Florida on rare occasions fills the above specifications, and the occurrence of snowfall there affords the nation's press a field day for editorial writers and cartoonists to chide Floridians for their "unusual weather." So it might be of interest, in view of the past winter's activity, to take a historical glance to see how unusual snowfall may be in the land of recent "frozen sunshine."

Though St. Augustine (1565) is the oldest permanent existing settlement of Europeans on the continent of North America, its early meteorological history was somewhat nebulous until it became part of the British Empire in 1763. Thereafter, we have sufficient material to chronicle the highlights of Florida's weather.

An early and reliable historian of the area, J. L. Williams writing in 1835 relates that snow fell over parts of present-day Florida in 1774, which, in good public relations style, the local residents referred to ever after as the "white rain."

What probably comprised the greatest of Florida snows occurred on 10 January 1800. Fortunately for us, on that very day Andrew Ellicott was surveying the then southern boundary of the United States. Ellicott was camping at Point Peter near the mouth of the St. Mary's River which separates Georgia and Florida at that point. His journal entries follow:

Jan. 10—Thermometer 37° at sunrise, rose to 40°
Snow and hail the whole day! which continued till 10 o'clock in the evening when the thermometer fell to 32°, the wind shifted to N.W. and it became clear at midnight.

Jan. 11—Thermometer 28° at sunrise, rose to 40°—
Snow five inches deep.

Jan. 12—34° at sunrise—rose to 67°

The winter of 1799–1800 was apparently a severe one of similar intensity and duration as that of 1957–58. Another cold spell occurred on 19–20 February 1800 when Ellicott noted: "a smart frost . . . ice ⅛" thick . . . wash water frozen at 7:00 p.m. . . . water frozen within 9 feet of fire." By the 23rd, however, it had become "very warm."

Three years later, on 15 February 1803, a very heavy snowfall spread over Georgia with undrifted depths of 18" reported in central parts of the state and the rarity of sleighing in the streets of Savannah. Whether the snow cover reached across the border into Florida is not known.

The next Florida snowfall of any consequence apparently did not occur for nearly half a century. None of the accounts of the most historic of all Florida freezes, that of 8 February 1835, makes any mention of accompanying snowfall. In the absence of positive information, we must assume that this

(*Continued on page 67*)

Weather Rambles

IVAN W. BRUNK, *U. S. Weather Bureau, Chicago, Illinois*

UNUSUAL(?) WEATHER

UNUSUAL weather in one part of the country, such as one of the most severe winters of record in Florida, seems to be frequently offset by contrasting unusual weather in another area. For example, 1957–8 is being called the "Year Without a Winter" in the Great Falls, Montana area, according to Thomas E. Jermin, meteorologist in charge of the weather bureau in that city. For a total of 67 consecutive days, from 30 November 1957 to 4 February 1958, the daily mean temperature remained above normal. This far exceeds any such previous record at Great Falls, where weather records date back to 1893. The first sub-zero weather of the winter did not arrive at Great Falls until 7 February 1958, and even at Chicago, the first sub-zero reading of the winter was not registered until February 8th. This helps to show that "normal" weather may be almost as elusive as the "average man" and that it may not be so unusual that the weather seems to be more unusual than usual this year.

SPRING IS HERE

Spring began this year at 2206 EST on March 20th, and we are now safely past the date of the dreaded "equinoctial storms," so-called. On the day of the vernal equinox, the sun in its apparent annual motion among the fixed stars crossed the celestial equator moving northward. The word "equinox," meaning "equal night," is used with reference to this date, and it is popularly supposed that on this day the sundown period is exactly equal to the total sunshine period. Reference to sunrise and sunset tables will show that this is not the case. This situation is due to two reasons:

(1) Sunrise is defined as the time the top of the solar disk crosses the horizon, and sunset is considered as the time when the top of the sun disappears below the horizon. As it takes a little time for the sun to travel its diameter, this much time is added to the day and subtracted from the night.

(2) When we see the sun rise and when it is observed to set, we are looking at light which came from a sun that is not where it appears to be. At those times the sun is actually below the horizon, and it can be seen only because the atmosphere acts like a prism, refracting or bending the light rays from the sun.

TORNADO-PROOF FRAME HOUSES

After the destructive Omaha tornado of Easter Sunday, 23 March 1913, which killed 95 persons and destroyed 600 homes, a number of tornado-proof houses were built in Kansas City by the late Col. Nelson, founder of the *Kansas City Star*. It is reported that the builder first surveyed the Omaha damage, and decided that the houses destroyed were of too light a type of construction. The houses built in Kansas City had two by six's for studding and twice as many nails as usually used. Other features included heavy bolts to anchor the houses to the foundations, and two large chimneys in each house to help anchor the buildings and also to furnish vents for rapid equalization of pressure in case a tornado funnel passed overhead.

As yet these houses have not been hit by a tornado, and it is not known for certain whether this type of construction is more tornado-proof than other types. The houses in Kansas City, Missouri, are on Harrison Street, between 47th and Brush Creek Boulevard, or about 7 miles north of the path of the destructive tornado which smashed through the southern edge of Kansas City on 20 May 1957.

THE RIDDLE OF THE GREAT LAKES

The Great Lakes provide a unique transportation artery and the volume of traffic compares favorably with that carried annually by the entire United States ocean-going merchant fleets. Most Great Lakes ports are ice-bound in the winter season, but during

the navigation season more total tonnage passes through the locks at Sault Ste. Marie, connecting Lake Superior and Lake Huron-Michigan, than the combined total carried through five other important canals, including the Panama and the Suez.

The levels of the Great Lakes fluctuate from year to year, and from month to month during each year. For nearly 100 years of record, the difference between minimum and maximum monthly mean elevations of Lake Michigan-Huron is slightly more than 6 feet, and the fluctuation in the monthly average lake level within any one year is usually over one foot. During periods of low levels, public and industrial facilities are sometimes built close to the shore lines, only to be damaged or destroyed at times of high levels. The most recent high water period was in 1952. In August of that year Lake Michigan-Huron was at its highest level since 1886. Since 1952, its level has been falling steadily, with the usual annual fluctuations, and in January 1958 it was nearly 4 feet below the high level of 1952.

According to the literature, many unsuccessful attempts have been made to correlate rainfall with the levels of the Great Lakes. However, a meteorologist, whose work has been almost completely overlooked by engineers and others, showed many years ago that "the water levels seem to be closely related to the quantity of precipitation, delays of a year or more often appearing in the response of the levels, since the run-off is not immediate." *

Rainfall in the Lake Michigan-Huron drainage basin was much above average in 1950 and 1951, prior to the near-record high levels in 1952. Since that time the precipitation has been below average in most years, but was above average in 1957, based upon rainfall figures for the Lake Michigan-Huron drainage basin computed by the U. S. Lake Survey, Corps of Engineers. Therefore, this may be some indication that Lake Michigan-Huron will decline at a decreasing rate in 1958, or may even be slightly higher than in 1957.

*P. C. Day, "Precipitation in the Drainage Area of the Great Lakes, 1875–1924," *Monthly Weather Review*, March 1926.

Letters to the Editor

Sir: It would be impossible for you to put out a publication of which any one issue would please every reader. To date I have not received an issue in which I did not enjoy some of the articles and pass up some of the others.

I think you have a great magazine just as it is with each issue containing an assortment of subject matter. Keep 'em coming.

W. H. Pico
Cavalier, N. D.

Sir: Well first I think *Weatherwise* should be published every month if not semi-monthly. Second, if possible more experiments in atmospheric physics and other phases of meteorology. Third, the magazine should have a page for its readers' comments.

Bob H. Pape
Chicago, Ill.

Sir: I have thoroughly enjoyed reading every issue of *Weatherwise* and have every copy on file from No. 1, Vol. 1. However, I have one request. I miss articles you used to have called "Workshop for Weathermen." I hope that you can resume that feature and similar ones on instruments and observing for the non-professional weathermen.

T. M. Hagood, Jr.
Paris, Texas

Sir: I feel that *Weatherwise* should be kept just as it is, and every effort should be made to restrict the publication to "interest" articles rather than "technical" articles *Weatherwise* is the only publication left for an amateur meteorologist.

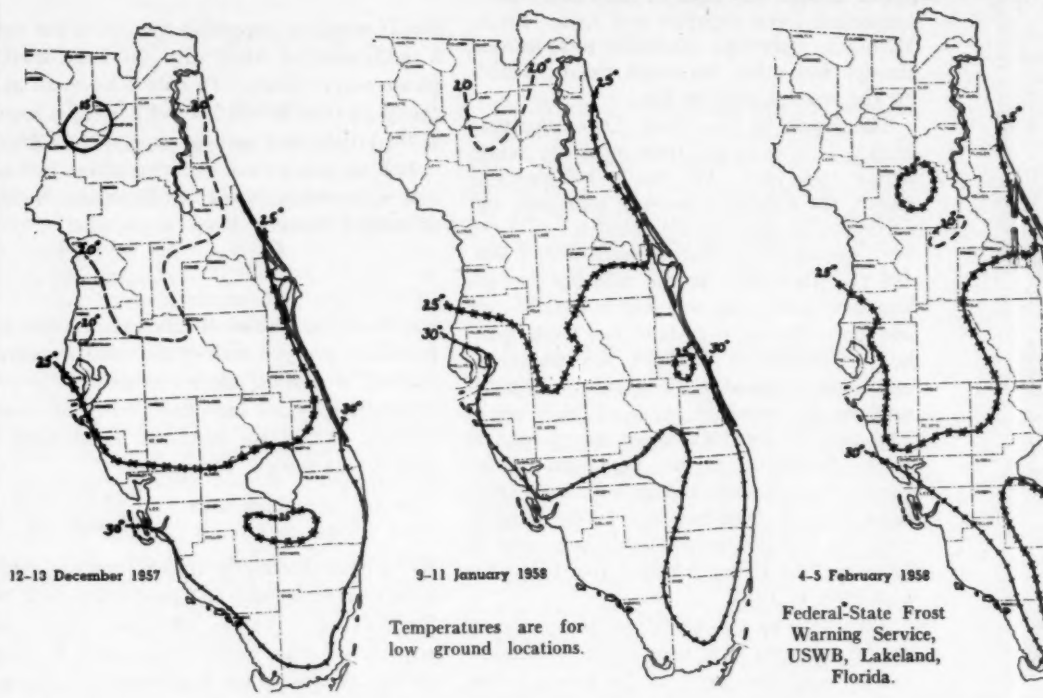
James B. Cope
Earlham College, Ind.

Sir: Thanks for the very interesting "The Washington and Jefferson Snowstorm." . . . Please keep *Wise* down to earth—let the long-hair stuff go to the *Bulletin*. I very much enjoyed the climat-tables—recalled my compilation of nearly 10 years ago.

Donald C. Cameron
Salt Lake City, Utah

(*Continued on page 66*)

Florida Freeze Pattern 1957–58



Temperatures are for low ground locations.

Federal-State Frost Warning Service, USWB, Lakeland, Florida.

Florida's Winter W

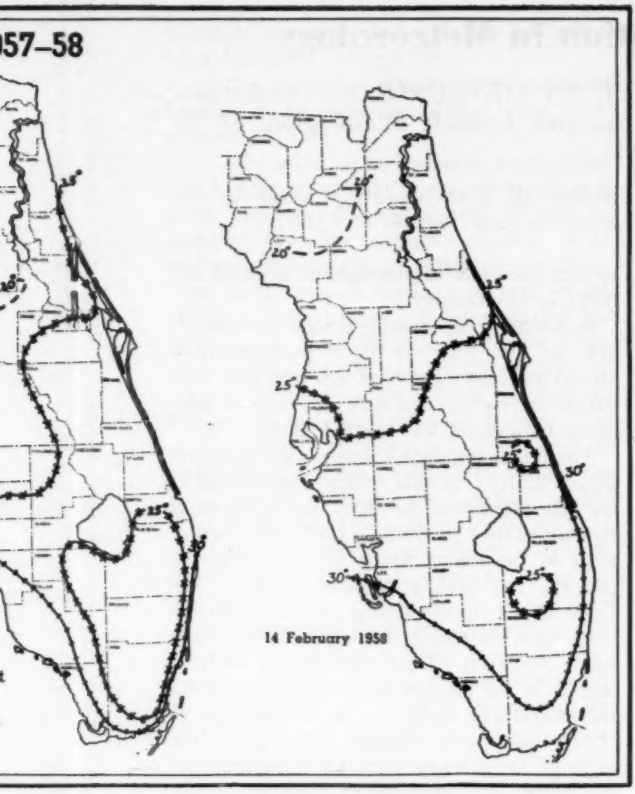
KEITH BUTSON, *State Climatologis*

THE 1957–58 winter weather conditions in Florida were noted for their record or near-record proportions. Recurring freezes, interspersed with strong winds and heavy rainfall in most peninsula areas, were adverse to nearly all facets of the state's economy. Snowfall, a rarity for Florida, was reported on two occasions: 8 January and 12–13 February. Numerous points recorded more days with freezing temperatures than ever before experienced during a winter season.

Temperatures for the season as a whole averaged the lowest since records have been kept. December was generally 2 to 4 degrees below average. January was 7 to 9 degrees below average and generally the second coldest January on record. February, in addition to being 9 to 10 degrees below average and colder than January, was the coldest month ever recorded in south Florida and the second coldest month ever recorded in the northern and western areas—February 1895 was slightly colder.

The cold was well distributed over the state; temperature departures displayed no marked geographic preference. Only the Florida Keys and some south coastal islands escaped the freezing. Although each month produced one or more destructive freezes, none was as severe as some noteworthy historic freezes as shown on the accompanying maps prepared by Federal-State Frost Warning Service, Lakeland, Florida. The record low temperature for Florida, 2 below zero at Tallahassee on 13 February 1899, was never seriously threatened. The lowest official temperature this season was 12° reported at two north peninsula points on 13 December.

Freezes of notable severity occurred during the periods: 12–13 December, 9–10–11 January, 4–5 February, 14 February, and 18–19



ter Weather: 1957-58

natologist, USWB, Gainesville, Florida

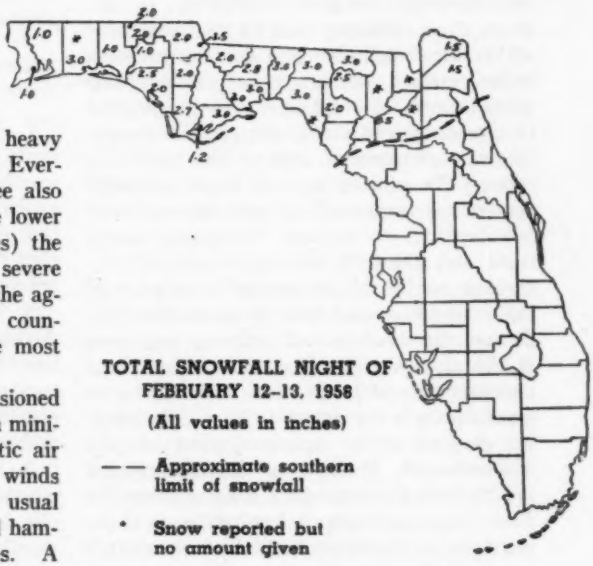
February. Freezing and relatively heavy frost deposits extended to the inland Everglades areas south of Lake Okeechobee also on 19 January. In all areas except the lower east coast (Dade and Broward counties) the December freeze was generally more severe than the subsequent cold periods. In the agricultural areas of Dade and Broward counties, the 4–5 February freeze was the most destructive.

The 12–13 December freeze was occasioned by the rapid southward movement, with minimum modification, of a very cold Arctic air mass from Canada. Strong northerly winds attending this cold wave minimized the usual high ground temperature advantage and hampered most freeze protection measures. A large portion of the anticipated all-time record Florida citrus crop was still on the trees and was exposed to the cold.

Following this first freeze, temperatures slowly returned to seasonal average levels which prevailed until the state was beset with the prolonged cold of January and February. In this interim of relative warmth the southern peninsula experienced excessive rainfall; the southeast coast on 2–3 January was visited by one of the worst winter storms ever felt there. The recurring rains of late December and January caused considerable inundation of southern rangeland. The flooding plus almost continuous low temperatures during January and most of February inhibited nearly all forage growth making livestock feed in critical short supply. Much farmland was either flooded or kept too soggy for cultivation. The intense storm of 2–3 January in the Florida Keys and the Dade-Broward-Palm Beach County area brought winds of 50 to 60 mph and 6 to 8 inches of rainfall. These strong winds and heavy rains played havoc with crops which had survived the earlier freeze, crops and seedbeds planted after the freeze, and most marine activities.

The successive movement of cold air across the state within short intervals throughout January and the first three weeks of February

(*Continued on page 74*)


TOTAL SNOWFALL NIGHT OF FEBRUARY 12–13, 1958
(All values in inches)
— — Approximate southern limit of snowfall
• Snow reported but no amount given

Research and Education in Meteorology

An Interim Report of the COMMITTEE ON METEOROLOGY to the National Academy of Sciences, National Research Council, Washington, D. C. 25 January 1958.

(The following excerpts from the full report include all recommendations made by the Committee. Full report and supplements will appear in June *Bulletin* of AMS.)

Preface

THE Committee on Meteorology was organized by the National Academy of Sciences in April 1956 for the purpose of bringing together scientists from meteorology and related physical and geophysical fields to view in broad perspective the present position and future requirements of meteorological research and to recommend the general outline of a program which would accelerate progress in this important field.

Very early in the deliberations of the Committee, it was recognized that the question of progress in meteorological research was inseparably linked to the problems of meteorological education and manpower. Ultimately two working groups were appointed to study in detail these two aspects of the central problem of progress in meteorology.

A series of six full Committee meetings was held during 1956 and 1957. The pattern of these meetings was soon established. It consisted of a judicious mixture of discussions within the Committee and conferences with active research workers in meteorology and related fields. Several sessions were devoted to an exchange of views with prominent educators in the general area of the earth sciences. The subjects covered in the technical conferences ranged all the way from current investigations on aurorae, ionospheric variations and tides in the upper atmosphere, through studies of the general circulation of the atmosphere and numerical weather prediction, the discussion of exchange processes at the air-ocean interface, and on to recent measurements of temperature and salinity at great depths in the Atlantic Ocean. By meeting at such widely separated points as the Massachusetts Institute of Technology and Woods Hole Oceanographic Institution on the East Coast and Scripps Institution of Oceanography on the West Coast, and at research centers in between, the Committee attempted to take the pulse of atmospheric research activity in this country.

In addition, the working groups on research and on education or their representatives visited as many centers of research and education as possible and held conferences with many individuals and small groups.

From this intimate contact with meteorological activity in this country, the Committee has attempted to distill its impressions and summarize its findings and recommendations in the report which follows. The experience has been a stimulating one. The Committee is unanimous in its belief that entirely new horizons of knowledge are opening up in the study of our atmospheric environment. If the recommendations of our group will materially assist in the exploration of these dimly seen horizons and provide the impetus for a more vigorous assault on the important and fundamental problems of meteorology, the Committee will feel that its mission has been accomplished.

Summary of Findings with Respect to Research

1. Although substantial advances have been made in recent years in meteorological research and many promising new avenues of exploration have been opened up, the magnitude of the present effort is inadequate to exploit fully the potential which exists at the universities.

2. The lack of stability in the support of meteorological research at the universities has had a deleterious effect not only on the total meteorological research program but also on the attraction of capable students and scientists to work in this field.

3. It is not always clearly recognized whether government support at the universities is for basic or applied research. This situation leads to confusion and frequently results in a bias of the objectives of the

research, which is inimical to the conduct of basic research.

4. The nature of the scientific problems that are to be solved requires a broad interdisciplinary effort.

5. The scale of the systems which come under the purview of the meteorologist is so large that the diagnostic tools of the researcher must by necessity involve large, elaborate and complicated equipment. Moreover, much research needs to be done in devising suitable probes for investigating the structure of the atmosphere and the processes which take place in the atmosphere.

6. While there is great merit in small investigations aimed at exploring specific areas of knowledge, fragmentation of research in meteorology has been carried to such a degree that it is difficult, under present circumstances, to mount the effort required for a fruitful exploitation of knowledge and techniques that have become available during the last fifteen years.

The findings of the Committee lead to the inescapable conclusion that a vastly augmented research effort is required if our national capability for research in meteorology is to be fully exploited and the scientific, economic and military needs met. Recognizing that the bulk of basic research is conducted at the universities, we have directed our first thoughts to find means for effectively increasing the present university research effort. Our assessment of the nature and importance of the problems being investigated, the means for pursuing these investigations, and the conditions under which the investigations are made lead to the first recommendation:

Recommendation 1

Present support for meteorology at the universities and kindred institutions should be increased immediately by fifty to one-hundred percent, to be directed toward support of basic research. The Committee recommends that the increase be sought primarily from federal agencies which support basic research, with assurance of stability of such support.

The above recommendation is deemed to be fundamental; yet the Committee does not feel that essential research objectives in meteorology can be met if this recommendation is carried out in its entirety. More is required than the simple strengthening of existing institutions. Indeed, the Committee believes that such a strengthening will take on its true significance only if additional means are found at the same time to tap the far larger reservoir of scientific manpower that exists in the parent fields of the basic sciences—physics, chemistry and mathematics—and to provide the research facilities of a size and scale commensurate with the global character of the problem. The Committee, therefore, makes the following additional recommendation:

Recommendation 2

A National Institute of Atmospheric Research should be established. This Institute should have the following characteristics:

a. It should constitute a center of intellectual activity that would bring together scientists from meteorology and the related physical sciences. To assure maximum benefit and effects in the education and training of graduate students, the Institute should be located in closest possible proximity to a university or universities having established graduate schools with strong departments in mathematics and the physical sciences.

b. It should provide research facilities on a scale required to cope with the global nature of the meteorological problem. These facilities would include modern scientific and technological tools such as a large-scale, high-speed electronic computer, a meteorological flight squadron, a laboratory for fundamental research on techniques for probing the atmosphere by electromagnetic radiation, and a laboratory for fundamental research on the use of satellites and rockets as probes of the atmosphere.

c. To assure the free movement of scientists between the Institute, the universities, and government agencies, it should be independently operated by a corporation sponsored by a group of universities under a prime contract with the National Science Foundation. The support of government agencies having interest in meteorology is highly desirable but should be arranged through a single contract and coordinated by the National Science Foundation.

d. Support should be provided at a level which would permit a capital investment of

fifty million dollars spread over a five year interval and an annual budget of approximately fifteen million dollars at the end of five years.

With able and imaginative leadership and strong support from the scientific community, particularly from the existing meteorological research establishments, such an institute would appear to be capable of fulfilling many of the needs for augmented research which the existing establishments cannot satisfy. It could at once offer career positions in atmospheric research to non-meteorologists and thus immediately establish effective contact with the parent sciences; it could engage in research activities which are not now encompassed by existing departments; it could maintain large research facilities which are not now available to individual departments and which would, in any case, overbalance their research and educational programs; it could provide a stimulating and effectual milieu and meeting place for research workers in allied or interrelated fields. In short, it could serve as the magnet to draw in the outside manpower that will be needed to make the order of magnitude increase in our present research effort, which we believe to be necessary.

Education and Manpower

If support for meteorological research on the scale recommended by this Committee is achieved, there remains the question of the adequacy of manpower resources in meteorology to meet the growing needs. It soon became apparent in the Committee's studies that the answer to this question must be in the negative. Manpower shortages are characteristic of all the sciences, so the answer was not surprising, but it was found that in many respects the problem is more acute in meteorology than in any of the other sciences. Except for the training of military students, whose excursion into the field is for the most part temporary, the output of meteorologists from the universities is inadequate to meet even the static needs of the science.

Summary of Findings with Respect to Manpower

The results of the Committee's review of the status of manpower and education in meteorology, based on data from current surveys and its own investigations, are given in the report of its working group on this subject reproduced in the Appendix. Some of the characteristics of the manpower situation in meteorology, most of which are peculiar to this science, may be summarized as follows:

1. Approximately 90 per cent of the working meteorologists are government employees, civilian or military. This concentration of meteorologists in the Federal Government is not the most effective way to advance the science.

It is well known that careers in the military and civil government services are unattractive to a majority of young scientists. This factor is believed to be one of several which cause students to shun meteorology. Industry is just beginning to realize the advantages that accrue through the employment of meteorologists. The funneling of meteorologists into business and industry would not reduce the numbers available for government service; it would be expected to so increase the attractiveness of the field of meteorology as to make a larger body of young scientists available for all types of duty. A student's initial distaste for government work often is overcome by the time he has been graduated and has become familiar with the caliber of scientific services and research in the government agencies.

2. A disproportionately large number (about 33 per cent) of meteorologists is in the 5-year bracket representing World War II veterans who are being followed by a wholly inadequate number of younger men.

None of the other sciences has so unbalanced an age distribution as meteorology. Unless something is done to fill the channel at the source, a sharp-crested wave of manpower will go through the field followed by a disastrous ebb. At the present time, the situation results in an absence of enough young men to fill initial career positions.

3. Salaries paid for meteorologists are comparable with those paid other scientists, and are at the top, on a par with salaries of physicists, for those with doctor's degrees.

This latter fact may be a result of a supply-and-demand situation, as suggested by the next finding.

4. The percentage of meteorologists with doctor's degrees is the lowest of any scientific group.

5. The percentage of persons with no degree at all, who are designated by their employers, by themselves or by their scientific society as meteorologists, is the highest of any scientific group.

This type of finding seems to result mainly from the near-monopoly in the field by the Government, and a lack of qualified career beginners. The U. S. Civil Service practice of: (a) permitting untrained persons to be promoted into essentially professional jobs on the basis of experience in lieu of education, and (b) eliminating the formerly useful distinction between subprofessionals and professionals is largely responsible for this situation. In the far-flung system of field stations of the U. S. Weather Bureau, many of the duties are of a routine nature which can be performed by persons of limited higher education. Lacking a nucleus of young college graduates of reasonable experience and competence, the Bureau puts older men somewhat deficient in educational background into positions of considerable professional standing. Similarly, the Air Force has airmen and the Navy has mates and chiefs making weather forecasts.

From the facts and interpretations given here, it is obvious that not enough students are going into meteorology. The existing educational facilities appear to be adequate to meet the requirements of equalizing the imbalance of manpower. The problem is to get the students; the difficulty is in communicating with the potential students.

Since meteorology is a derived science (derived from physics, mathematics, chemistry, etc.), it is difficult for the student to be in touch with it before he has completed fairly extensive work in the background fields. By that time he may have already decided to become a physicist or a mathematician. The fact that classical physics and applied mathematics no longer are "in style" may aggravate the situation. Furthermore, meteorology is taught only at a few schools and the high school and college curricula hardly make mention of it. The student obtains his impression of the field from the television and newspapers in which the "meteorologist" is pictured as a weather man making pseudo-scientific attempts to forecast the weather.

On a scale in keeping with its limited resources, the American Meteorological Society is currently carrying on a program to stimulate interest in meteorology. The experience and facilities of that organization can be used to improve the manpower situation.

Recommendation 3

It is recommended that the American Meteorological Society take the initiative and responsibility for increasing its activities in stimulating interest in meteorology ten-fold or more, and that, as necessary, it seek federal funds for this purpose, preferably from the National Science Foundation.

The details for carrying it out and costs proposals should be furnished by the Society based on its experience. The objective of this undertaking should not be an attempt to attract all students into the field of meteorology, but to provide them with the opportunity to choose this field if it interests them. Included in the program should be the following activities:

a. Reach students through contacts with schools, through published material and publicity, through television, etc., to stimulate their interest in meteorology.

b. Develop industrial and other non-government career opportunities which would make the field more attractive.

c. Assist high schools and colleges in establishing general courses designed to acquaint students with the field of geophysics, in general, and of meteorology, in particular.

d. Prepare a comprehensive career bulletin on meteorology.

e. Promote the preparation of text material in a unified series on meteorological subjects for high schools and elementary schools. Film material should be included. (See also Paragraph 6 of the following section.)

f. Provide assistance to high schools and colleges, by way of printed material and films, for example, to enable teachers and others to be more effective in their guidance and counseling responsibilities.

Summary of Findings with Respect to Education

The situation with regard to meteorological education, covered fully in the Appendix, may be summarized as follows:

1. There appears to be a need for revision of the university meteorological curricula to

embrace the new aspects introduced or envisaged by leading scientists in the field.

Actions taken and trends being followed at M.I.T. and Chicago are examples of the reorientation needed. At M.I.T. the graduate program has been combined with a special curriculum in the Earth Sciences. As background for specialization in any of the Earth Sciences, including meteorology, the students follow a program in classical physics. A laboratory of the Earth Sciences is the center around which the program is developing. At Chicago, new developments in atmospheric physics and chemistry, including coordination with other sciences, have been incorporated into a specialization in meteorology, with a reduction of the attention paid to standard weather forecasting routines.

2. High schools and colleges need assistance in establishing general courses designed to acquaint students with meteorology as a fundamental and exciting part of geophysics.

3. A general need is expressed for new university meteorological textbooks, but there is no indication of willingness on the part of qualified persons to give up important research and teaching to prepare the required texts unless better support for this type of work is made available.

4. Scholarships and fellowships at all levels are either inadequate or are not playing the part they should in bringing young scientists into meteorology. More predoctoral fellowships might help to increase the number of Ph.D's. to a proper proportion. On the other hand, of about 900 predoctoral, postdoctoral and faculty fellowships granted by the National Science Foundation in the last six years, only six have gone to meteorologists. This might indicate a general lack of knowledge among meteorological students regarding the extent of the fellowships available in the physical sciences through the National Science Foundation.

5. The Committee finds that meteorology can benefit and has benefited by the attraction of scientists in related fields to turn attention to meteorological research problems that might interest them. Such scientists could be attracted through postdoctoral fellowships.

6. There is much to be done at the levels of the secondary and elementary schools to improve the manpower and meteorological or science education programs. Many of the problems are common to science as a whole. Text material, career counseling material and direct approaches to students and teachers are necessary. (See recommendation under manpower findings on preceding pages.)

7. The Weather Bureau has an active education program, but to meet new scientific challenges and to improve the general educational level of its employees, these activities could well be expanded.

8. It has been found that there is a desire for the universities with meteorological departments to band together in order to put into effect programs necessary for keeping up with or actually promoting the new surge in the growth of the science which appears to be imminent. Relationships to other sciences are to be considered.

RECOMMENDATION 4

Representatives of departments of meteorology at the universities should form an inter-university committee to consider curricula, student recruitment, fellowship and textbooks.

This Committee might:

a. Explore with the National Science Foundation, private foundations and industry the question of adequate scholarship and fellowship support and the full use of available support;

b. Improve and modernize curricula in keeping with the new trends in meteorology;

c. Explore the possibility of alleviating the textbook shortage by obtaining special grants to qualified writers of textbooks so that they may take time off from their teaching duties to do their writing and have income to supplement the small royalties they will receive;

d. Cooperate with the American Meteorological Society in improving contacts with schools and colleges where a source of potential manpower may be reached;

e. Review needs and problems in meteorological research;

f. Offer assistance to the Weather Bureau and other agencies in the improvement of combined educational and personnel situations in these agencies.

RECOMMENDATION 5

The Chief of the Weather Bureau should be offered the help of a committee of university meteorologists in the educational and personnel development programs of the Bureau.

A committee consisting of three university meteorologists, one university general educator and a Weather Bureau representative could periodically review the programs and make recommendations for improvements. The committee members should make frequent visits to field stations to encourage and counsel personnel concerning individual and group education programs and to make sure that highly promising young scientists are not left undiscovered. The committee should concern itself also with the personnel actions of the Bureau as they relate to the educational problems, with a view toward the accomplishment, within the Bureau, of a general elevation of the education and professional competence of personnel. Discussions with the Civil Service Commission and others aimed at raising the professional stature in the Government service might be included in the activities of the committee.

Recommendation 6

The university meteorological committee and other interested meteorologists should acquaint themselves fully with the availability of fellowships and scholarships in the sciences, and take the responsibility for providing guidance and direction for well qualified students to obtain such assistance toward their education in meteorology.

Members of the Committee

Lloyd V. Berkner, Chairman, Associated Universities, Inc.
Horace R. Byers, Vice Chairman, University of Chicago
Henry G. Booker, Cornell University
Jule G. Charney, M.I.T.
Hugh L. Dryden, National Advisory Committee for Aeronautics
Carl Eckart, Scripps Institution of Oceanography
Paul E. Klopsteg, National Science Foundation
Thomas F. Malone, The Travelers Insurance Companies
Edward Teller, University of California

Secretary of the Committee:
John R. Sievers, National Science Foundation, Washington 25, D. C.

Flying Saucers (*Continued from page 45*)

tion of a lee wave, and because of the moisture stratification and wave shape the orographic clouds appeared above and downwind from the peak.

Diurnal Variations

Earlier it was noted that orographic clouds are generally stationary but that there are exceptions to the rule. In fact from Mr. Scaylea's description it is apparent that we are here dealing with a case in which quite rapid movement occurred. It is interesting to consider what theory has to say on this point. According to Scorer's (3) results, the wave length depends on lapse rate, wind speed, and wind shear. These parameters undergo rapid change in the lowest layers at the times of sunrise and sunset: that is, the cloud should move away from the peak in the morning and perhaps dissolve and then reform and move back towards it in the evening. Such effects have been noted by a number of observers in different parts of the world; and, recalling that Mr. Scaylea first saw the cloud at sunset, we can say that his observation was consistent with both theory and prior observation.

Surrounding stations in the northerly and easterly quadrants reported fog and stratus much or all of the day and temperature ranges of only 3–4° F. Stations in the southerly quadrant, however, especially those at higher elevations, experienced rather large diurnal changes. Thus the Paradise ranger station located five miles south of the peak at an elevation of 5,550 ft. reported a maximum temperature of 58° F. and a minimum of 36° F. with a reading of 47° F. at 4:30 p.m., while at Seattle the temperature ranged between 30° F. and 34° F. and at Yakima between 25° F. and 28° F. Although the diurnal changes were slight over the area as a whole, there were pronounced effects in the vicinity of the peak.

The Original Flying Saucer Incident

Menzel (4) states that the current flying saucer craze began on 24 June 1947, when Kenneth Arnold, a businessman from Boise, Idaho, was making a flight in a light plane from Chehalis to Yakima, Washington. As he neared Mount Rainier, he sighted a chain

of unidentified objects flying close to the mountain. But let us examine his own account.

"I could see their outline quite plainly against the snow as they approached the mountain. They flew very close to the mountain tops, directly south to southeast down the hogback of the range, flying like geese in a diagonal chainlike line, as if they were linked together.

"They were approximately 20 or 25 miles away, and I couldn't see a tail on them. I watched for about three minutes—a chain of saucer-like things at least five miles long, swerving in and out of the high mountain peaks. They were flat like a piepan and so shiny they reflected the sun like a mirror. I never saw anything so fast."

The implication that Mr. Scaylea and Mr. Arnold viewed essentially the same phenomenon seems inescapable. We can never know for certain that this is the case, but we can test our hypothesis by inspecting the weather maps of 24 June 1947 to determine whether atmospheric conditions were basically similar to those on the later date. To be comparable, winds would have to be blowing from the north or northwest in Mr. Arnold's case since the objects were sighted to the south and southeast of the peak. The air would have to be dry at lower elevations and moisture would have to be spreading in at higher levels. An inspection of the historical maps series reveals that, indeed, all these conditions were met.

No doubt a wide variety of natural phenomena are associated with the many reports of flying saucers. Only a small fraction of the sightings can be attributed to orographic clouds. But thanks to the fortuitous presence of Mr. Scaylea on Pigtail Peak on that unusual December day in 1956, we can now give a rational explanation for the incident which started the flying saucer epidemic of the past ten years. The first of the unidentified flying objects appears at last to have been identified.

ACKNOWLEDGMENTS

Without the cooperation and help of the following persons this article could not have been written in its present form: Messrs. Josef Scaylea, James Sullivan, Marvin Magnuson, Miss Helen Earnheart and Dr. Robert G. Fleagle.

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Letters to the Editor

(Continued from page 57)

Sir: Let me first say that as a professional I certainly enjoy the informal, but informative type of article that *Weatherwise* publishes. There is certainly a need for such articles, and I know the magazine is read by many oceanographers here and is also enjoyed by the cooperative observers of the Weather Bureau in this area.

There are some types of information which I do not believe are published in any of the U. S. journals. . . . These are short notes, one or two paragraphs of interesting or unusual phenomena. They are the kind of things that any observer of the weather notices and finds interesting, but there is no way of disseminating them other than by word of mouth. A feature in *Weatherwise* such as an "Observers Exchange" would be appreciated by amateur and professional alike.

RICHARD FAY
Woods Hole, Mass.

Sir: I have an idea, or request for an article which may be of interest to others besides myself.

I used to be fairly good at short range forecasts, using single station analysis based only on visual observations. Would an article or series presenting a refresher course in the method be feasible? Outdoorsmen and boating enthusiasts might find such an article useful, as well as interesting!

I hope that this letter is of some aid in your "navigation," and I do want you to know that I've been enjoying *Weatherwise* for a long time (as long as the AMS has been sending it out to members).

JOHN L. CERUTTI
Gainesville, Fla.

Florida Snow (*Continued from page 55*)

was a clear, dry cold as the + 8° registered at St. Augustine would indicate.

Weather records for Jacksonville are in satisfactory shape for our immediate purposes from 1844 to date, and they have been carefully combed by T. Frederick Davis in the *Monthly Weather Review* (1907) for snow data. The records indicate a measurable snow over northern Florida took place on 13 January 1852 during a notably cold winter month. The local observer at Jacksonville measured 0.5″, but Tallahassee had 2.0″ according to press dispatches. The records at the former place for the next half century indicate nine occurrences of "a few flakes . . . light snow . . . flurry . . . sleet," but no measurable snow until 1899.

Due to its geographical position the western part of Florida is more subject to snow situations and invites a deeper penetration southward of snowfall. In the winter of 1886–87 Pensacola had 0.5″ in December and 1.0″ in January. At Tampa enough snow fell for snowballing. This marks the only winter previous to 1957–58 during which snow fell in Florida in two successive months.

The cold winter of 1894–95, when a double freeze caused the greatest destruction among citrus orchards since 1835, witnessed a good old-fashioned snowstorm of 3″ at Pensacola with sleighing and 2″ at Tallahassee on 8 February 1895. At Eustis in central Florida snow fell on both the 14th and 16th with no accumulation, and some "fine snow" was reported in Manatee County near Sarasota.

By far the most extensive snowstorm in modern Florida history accompanied the Great Cold Wave and Eastern Blizzard of February 1899, the month which wrote so many bitter records into the weather books of the Southeastern States. This was the greatest of all recorded Arctic outbreaks in the United States when temperatures at Tallahassee plunged to − 2° on the morning of 13 February, the absolute minimum for Florida. The deep penetration of the frigid air is shown by the following minima at southern points: Tampa 22°, Ft. Myers 28°, Boca Raton 28°, Key West 44°.

As a wave formed on the original cold front, a snowstorm enveloped most of the peninsula, spreading a blanket of white an inch or more deep as far south as Tarpon Springs near St. Petersburg. A trace was noticed at Ft. Myers at 26° 35′ N on the West Coast in the same latitude as Palm Beach. Tampa had an official 0.1″ and again some enterprising citizens engaged in snowballing. In the north the falls were much heavier with observed amounts of 4″ at Lake Butler and 3″ at Lake City in the base of the peninsula. Pensacola had 2.1″. The snow reached across the peninsula to Jacksonville where the fall of 1.9″ was the first measurable snow in 50 years. Traces fell along the East Coast as far south as Daytona Beach.

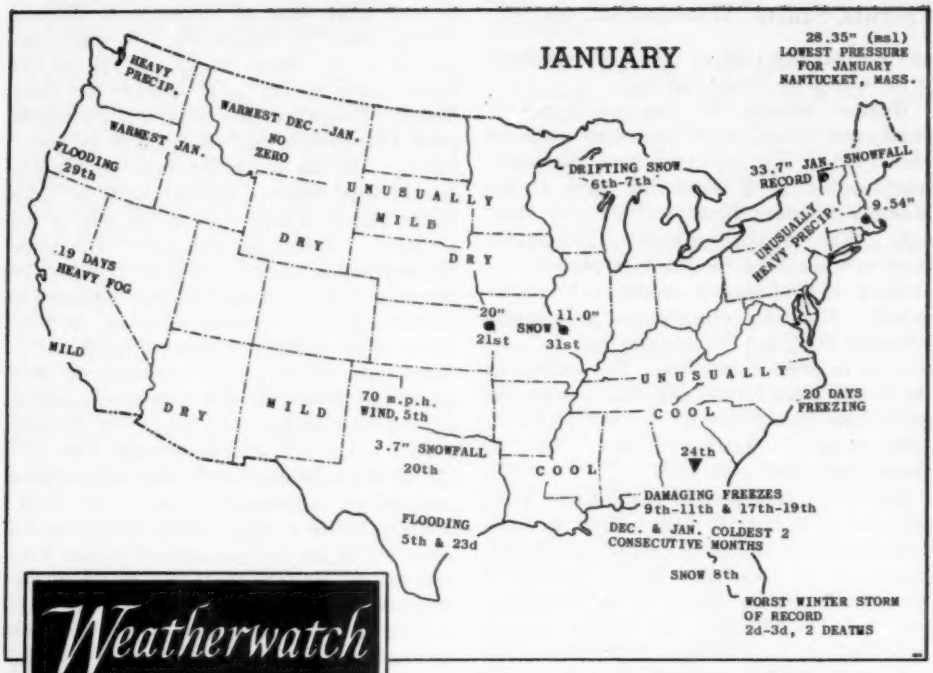
After the snowy period attendant the decade of the 1890's, we hear little of measurable snow in Florida for many years. In January 1935 a fall of 1.0″ covered Panama City and 0.2″ at Apalachicola, but appears to have been confined to northwestern parts of the state.

Early in the present decade a substantial snow fell in the St. Augustine-Crescent City area where measurements by Weather Bureau observers reached 2.0″ on the night of 2–3 February 1951. Traces fell as far down as Bradenton on Tampa Bay in the west and Daytona Beach in the east.

The winter of 1957–58, now rated the coldest three-months span in the peninsula's history, contributed among other things two snows to the record books. Snow flurries broke out in the northwesterly flow of cold, unstable air on 8 January 1958 with traces as far down as Orlando and Lakeland. At the latter place visibility was reduced to two miles and children were let out of school to witness the spectacle. Flakes were also noticed in the vicinity of Tampa to the north and east of the city.

The second snow of the winter came from a real cyclonic disturbance which moved across the central Gulf of Mexico and traversed the south-central part of the peninsula. On the morning of 13 February Tallahassee measured 2.8″ after an overnight fall. Both Pensacola and Apalachicola had 1.0″. Many northern stations reported 3″ even.

In summary, it appears that Florida experiences a major snowstorm about once every fifty years, that flurries will occur in the north about twice every decade, and that the Ft. Myers-Lake Okeechobee-Ft. Pierce line represents the farthest south, surface penetration of the white flakes.



Data by Office of Climatology, USWB.

Winter 1957-1958: A Divided Nation

DAVID M. LUDLUM, *Editor*

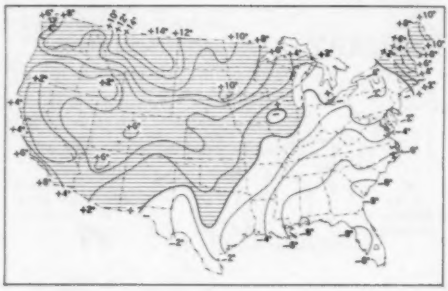
The general circulation over the United States during the first two weeks of the New Year continued the regime which had prevailed during the very mild month of December. It will be recalled that the last five weeks of 1957 comprised a warm ending to a relatively cool year for the nation as a whole. The only exceptions to the December warmth occurred in the interior valleys of California and the Southeast coast from South Carolina to Mississippi with the atmosphere over Florida forming the core of the cold air.

For the first two weeks of January westerly flow continued to transport mild Pacific air across western United States during a high index cycle. Barometric pressure at the surface remained high in the West and relatively low in the East. Ridge conditions over the western United States and Canada excluded cyclones from penetrating inland. Mild temperatures favored both coastal and inland sections with the latter receiving much additional chinook warming. It was the warmest January on record at some Oregon points and in western Montana not one day in January 1958 averaged below that day's normal.

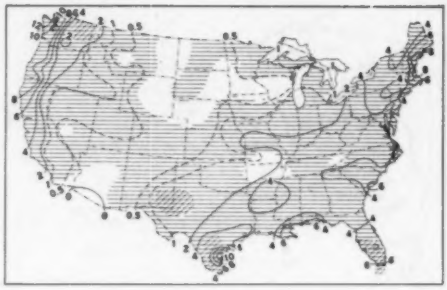
Over the East trough conditions prevailed with the mean trough showing a progressive eastward movement as the month wore on. The southern end of the persistent trough in the Gulf of Mexico favored cyclonic formation there—a feature of mid- and late winter 1958 which produced an almost unprecedented period of cold storms and frigid temperatures over the entire Southeast.

The cycle of west-east flow broke down in spectacular fashion at mid-month with a very rapid decline of the strength of the westerlies in the middle latitudes. The behavior of the jet stream well illustrated the changes which were in progress on the circulation charts. The jet, which is most intense during a high index cycle, reached its peak speeds about 20 December when it was found near 47° N, close to the U. S.-Canada border. Thereafter, it migrated farther and farther southward—by mid-January it was near 40° N and by early February at 33° N over the Gulf States. At the same time there was an abnormal increase in westerly circulation across the sub-tropics of Mexico and the Gulf.

The rearrangement of ridges and troughs to accommodate the new circulation was signaled by the very rapid build-up of a blocking anticyclone of great magnitude over the Greenland-Baffin Land area. Surface barometric pressures reached extreme values there on 18 January 1958 when two stations on opposite sides of Baffin Bay reported 1064 mb (31.42″) and map analysts interpolated a central



Departure of Average Temperature from normal in degrees Fahrenheit. USWB chart.



Total Precipitation in inches. USWB chart.

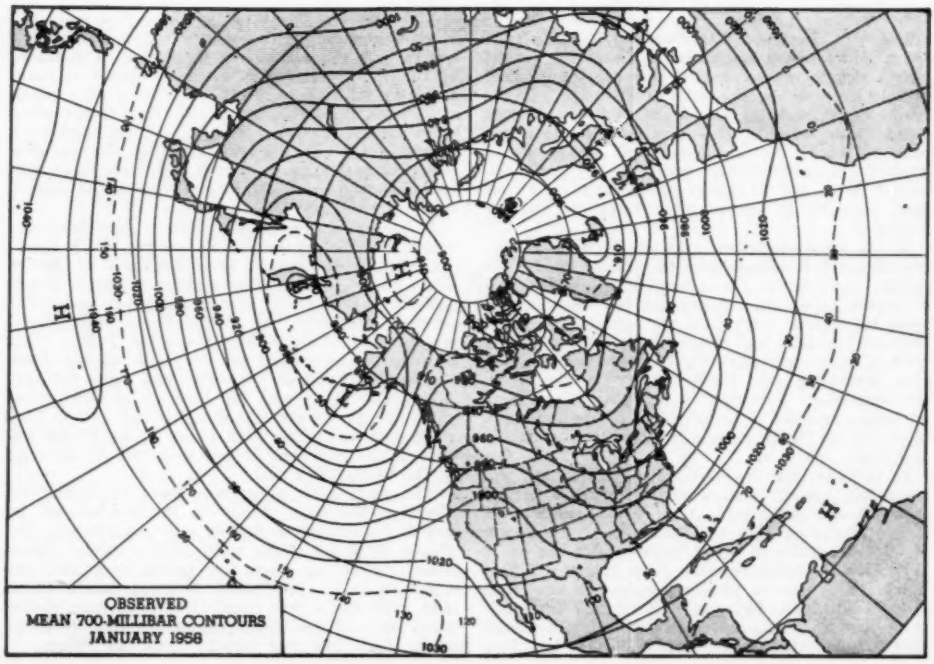
pressure of 1066 mb (31.48″). The presence of this great block was of paramount influence in creating the southward transport of northern air masses which constituted the cold, snowy late winter in the eastern half of the United States. At the same time the anticyclonic flow stimulated easterlies in the polar regions bringing mild maritime air from the Atlantic over much of Canada during January and early February. Maine and occasionally the rest of New England shared in this easterly circulation to create a varied weather pattern there in January.

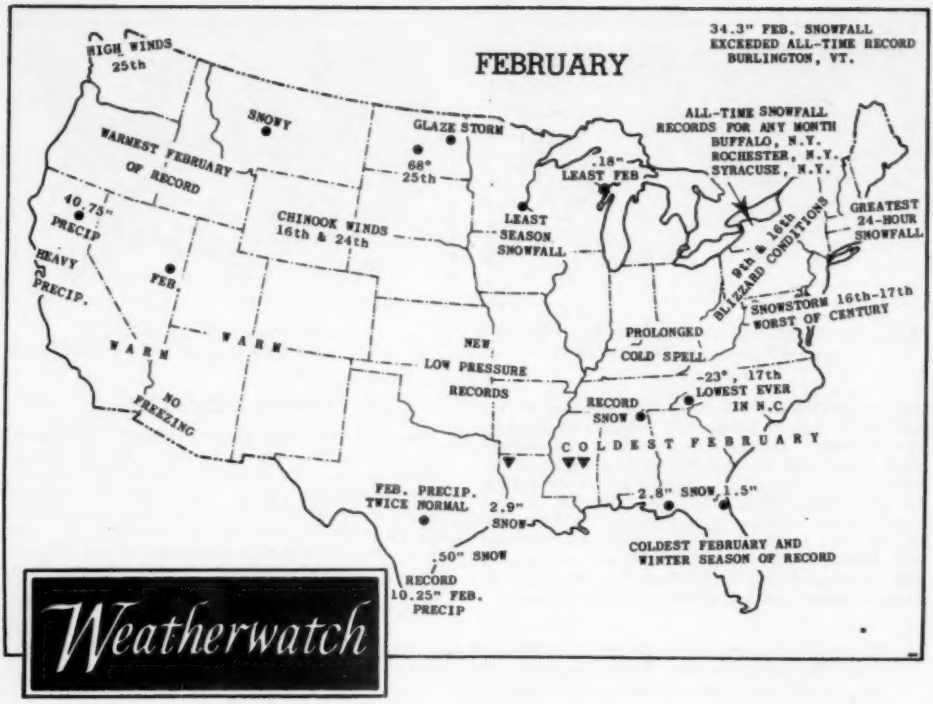
STORM ACTIVITY

The most important cyclonic activity of January took place in the Gulf of Mexico. The jet stream flowing in from the Pacific over central California dipped southeastward to Texas and the Gulf of Mexico in its eastward rush, and this was the path that disturbances followed or developed in. The first storm of the month originated on 2–3 January near the Yucatan Peninsula, crossed western Cuba,

(*Continued on page 73*)

The upper-air map below shows the pattern of air flow for January at about 10,000 feet, on which the average weather largely depends. The contours lines represent the mean height of the 700 mb. pressure level. Figures are in tens of feet: 1020 = 10,200 ft., 980 = 9,800 ft., etc. Chart by Extended Forecast Section, USWB.





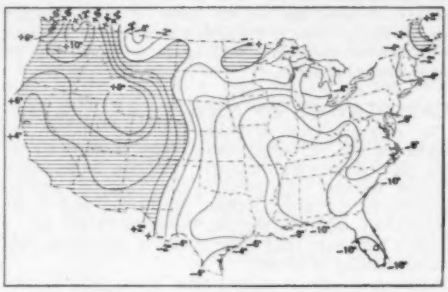
The main circulation features which had developed about mid-January and given its latter two weeks such a definite meteorological personality continued to hold sway throughout most of February. In the Pacific Ocean south of Alaska the deep low centered about 700 miles south of Kodiak remained to dominate the entire North Pacific area. It formed a mecca for eastward-moving cyclones. Sea level pressure at 45 N, 140 W (about 300 miles west of Oregon) averaged 16 mb or 0.50″ below normal for February.

Strong ridge conditions over the Pacific and Plateau States downstream from the intense Pacific low shunted most storm centers northward into the Gulf of Alaska rather than permitting movement inland along the normal track. On the eastern side of the ridge an unusually well-defined front could be found most of the month along the crest of the Great Divide, separating mild Pacific air to the west from the bitter polar outbreaks to the east. There were no break-throughs of polar air down the mountain passes to the Pacific as usually occurs once or twice a winter.

In the East the contours and circulation pattern resembled that of January with a trough extending from Quebec southward over New England and thence southward close to the coastline. The center of cyclonic action in the Atlantic trough showed a northward migrating tendency from January to February. The greatest pressure departures now were found aloft off the Delaware and Virginia Capes and at the surface to the east of Cape Cod. This small shift had important effects on the air flow into New England and the Middle Atlantic region. The previous easterly circulation was supplanted by a northerly flow. The extremely moist air masses of January were replaced by much drier and colder conditions associated with continental flow except when their prevalence was momentarily interrupted by a coastal disturbance. New York City, for instance, had ten consecutive days with temperatures consistently below freezing, the longest such period ever to occur in February.

In the Arctic the blocking high in Greenland area remained the chief steering feature for North America. Sea level pressure there averaged 12 mb or 0.40″ above normal. One significant change developed in the Arctic as the month progressed. The western ridge over the United States built northward to cover part of Alaska and the Yukon. This provided an easy path for Arctic air to slip down the eastern flank of the ridge and pour into the Mississippi Valley and the East. The build-up of the ridge to Alaska signaled the end of the long mild spell in the northern Great Plains as the Pacific-Arctic front was pushed westward to the crest of the Rocky Mountains.

The zonal index of westerly flow, which had declined to low levels about 12 January, reached its lowest ebb during the first days of January and continued at a low stage until 20 February. Thereafter, Pacific air again penetrated deep into the continent to rout the frigid conditions in the Plains and East for a few days. But again the closing three days of the month brought a resumption of north-south flow as a blizzard swept the Plains.



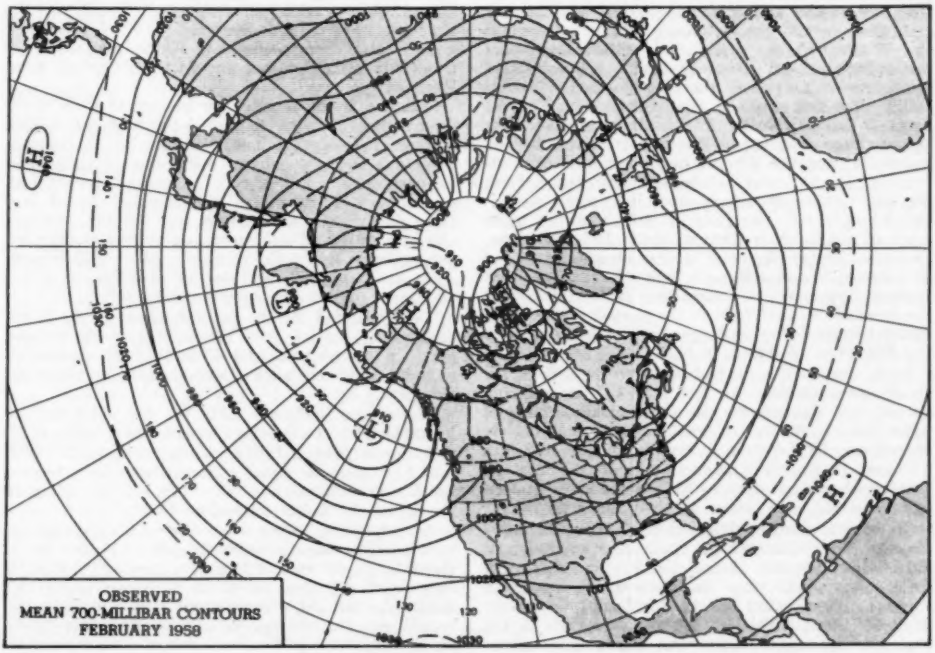
Departure of Average Temperature from normal in degrees Fahrenheit. USWB chart.

Total Precipitation in inches. USWB chart.

THE GREAT SNOWSTORM—Once in a lifetime a great snowstorm will occur and thereafter supplies an unlimited source of reminiscences and material for ever-growing tall tales. Writing in 1831 about a great current storm, Ebenezer Niles, the Baltimore editor, declared it "a genuine old-fashioned snowstorm" and "worthy of the best days of our fathers."

The storm which swept the Atlantic seaboard and Appalachians highlands on 14–16 February 1958 was of major stature. It spread a blanket of snow twelve inches or more deep in a broad band from northeastern Alabama to the Canadian border, and beyond. Some states and local areas have had heavier falls of snow within memory, but no storm of the present century combined the magnitude of areal extent and the intensity of frozen precipitation as did the Great Snowstorm of Mid-February 1958. Snow historians have been duly consulted, and they have culled from the records of the nineteenth and twentieth centuries only three worthy predecessors: The Great Atlantic Coast Snowstorm of 14–16 January 1831, The Carolina to New England Blizzard of 18–19 January 1857, and the Great Eastern Blizzard of 11–14 February 1899. So snow watchers of the present generation in the East can relax for they have had their big snowstorm! (Some parts of Maryland, Delaware, Pennsylvania, and New Jersey received even greater amounts during the Eve of Spring Snowstorm on 19–21 March 1958; nevertheless, the intense storm area was limited in extent, the snowfall was generally a slushy mess, and the meteorological situation was not one to inspire the admiration of the weather historian or forecaster.)

The genesis of the storm lay in a low pressure impulse which moved across the Plateau and Rocky



Mountains states on 13 February. It joined the semi-permanent front along the eastern slopes of the Rockies which during most of January and February formed the boundary between mild Pacific and cold polar air. The center slid rapidly southward on the 14th to the Texas Panhandle under the influence of a strong southerly-displaced jet, then southeastward to the Gulf of Mexico where it emerged about noon of the 14th as a 1008 mb (29.77″) low. Twenty-four hours later the center was on the South Carolina coast at 996 mb (29.42″) and another twenty-four hours took it to a position off Cape Cod, Massachusetts, with pressure down to 976 mb (28.84″).

As the depression moved across the warm waters of the northern Gulf of Mexico, all the ingredients of a good coastal snowstorm were present, so the alarms were sounded to the northward and a good forecasting job resulted. At midnight of the 14–15th a sizable anticyclone of 1032 mb (30.48″) was poised just north of the Dakotas with temperatures running as low as − 25° F., and the anticyclone looped eastward over Quebec with below-zero readings there, as is required for classical eastern snows. So there was no lack of cold air.

As the low pressure center skirted the coastline of the Gulf States, it was in good position to draw on the tropical air masses latent there with their copious supply of moisture. Thus, the intensifying low was able to set enormous quantities of moisture flowing northward over the dome of cold air which had been pushed into the Mississippi Valley by the northern anticyclone. Snow broke out from Lake Michigan to Arkansas, and southward to Mississippi and central Alabama. Three inches were measured in northern Mississippi and as much as 12.5″ at Haleysville in northeastern Alabama.

An important factor in causing the heavy snows so far inland lay in the path of the low center which remained inland about 50 miles from the coastline over Georgia and the Carolinas until it emerged at the Virginia Capes. This drew Atlantic moisture far enough inland to areas where below-freezing temperatures prevailed, resulting in heavy snows rather than rain over an ever-widening belt northward to Lake Ontario. Practically all areas in the Appalachians and upper Piedmont received 12″ or more. Washington Airport had an official 14″, Allentown, Pa. 18″, and Boston 19.4″ for some of the big city totals. Mountain areas had much more—the Poconos 36″, the Catskills 30″, and the highlands of interior New England up to 30″. The Boston area boasted the most intense snowstorm in the 75 years of Weather Bureau snowfall records. Both Boston Airport's 19.4″ and Blue Hill's 22.2″ were the greatest 24-hour falls in the record books. Old timers admitted they had seen nothing like this since the Big Snow of February 1717.

Snow depths after the end of the storm approached record proportions. At Syracuse 48″ lay on the ground, at Tannersville in the Catskills only 90 miles from New York City—65″, at Lebanon, New Hampshire, 58″, and at Limestone, Maine, 62″. In Vermont Burlington's accumulation of 32″ was the greatest of modern times. Ski resorts in the mountains reported snow cover of 100″ and more.

The storm assumed blizzard proportions in many areas of the Middle Atlantic States and western New England during the closing hours of precipitation. Gale force winds from the northeast increased in force as they backed to the north and northwest. The dry snow, which fell with temperatures in the low 20s and upper teens, was blown into mountainous drifts, and for 48 hours and more defied the efforts of snow fighters to keep the main arteries open. Many country roads remained closed for 5 to 7 days after the storm with great economic loss to rural communities.

LAKE SNOWS OF NEW YORK STATE—The lee shore areas of Lakes Erie and Ontario experienced one of their greatest snow seasons during the past winter with records tumbling in unprecedented fashion. All three major Weather Bureau stations in the area, Buffalo, Rochester, and Syracuse, along with Burlington, Vermont, in the lee of Lake Champlain, had their snowiest individual calendar months in history.

The snow belt of central New York State usually gets a double dose of snow from each passing cyclonic system. It shares in a general snow which accompanies a storm center moving up the Ohio Valley through Virginia or Pennsylvania, and it also receives moisture from the expanding precipitation area of a coastal storm moving up the Atlantic seaboard from the South. With the shift of wind to the northwest or west after the passage of a storm center, the snowfall enters a second phase—it not only continues, but often intensifies as the westerlies, moving across the ice-free waters of Lake Ontario and Lake Erie, pick up moisture and deposit it a few miles inland in the form of very heavy snow showers. The snowfall often continues as long as the westerly air flow continues, sometimes for 48 to 72 hours. Probably the greatest of lake snows occurred under the above circumstances on 8–10 January 1836 when an average of 48″ fell over the Rome-Utica-Syracuse area in a three-day continuous snowfall.

The present winter of 1957–58 has contributed the greatest total monthly falls in Weather Bureau history. After impressive January totals, the following figures were reached in February: Buffalo 54.2″, Rochester 64.8″, and Syracuse 72.6″. The only greater totals from preliminary figures were 78.0″ at Constantia near Syracuse and 74.1″ at Garbutt near Rochester.

Syracuse is the largest city in central New York State; the following figures show what an added burden an important industrial city has to contend with in a rigorous winter. After the sixth snowiest January with a fall of 35.6″, leaving a month-end covering of 9″, February had snowfall on all but three days: eight were traces, but the rest measurable quantities. There were two storms of blizzard proportions: on 7–10 February 25.3″ fell raising snow cover to 38″, and on 15–19 February 26.2″ additional upping the snow depth to 48″.

Total snowfall for the current winter to April 1st at Syracuse totaled 140.3″, compared to the greaest previous season's total of 146″ in 1955–56. Rochester had its third snowiest January and its snowiest February.

Burlington, Vermont, made the unique record of breaking both the existing January mark with 33.7″ and the existing February mark with 34.3″. The monthly totals have been exceeded only once before, by March 1896 with 37.0″. The season's total at Burlington to April 1st reached 94.1″.

An interesting sideshow to the main performance took place at Michigan City, Indiana, 40 miles across Lake Michigan from Chicago, where 42″ fell in a very restricted area on 15–16 February under the same type lee shore mechanism that produced the record snows at the eastern end of the Lower Lakes on the same days.

A PLAINS BLIZZARD—An active central Pacific low moved inland over Washington on 24 February and pushed southeastward across the Plateau and Rocky Mountain region accompanied by a mild air stream. At the same time, just to the north of the Canadian border, a wave formed on the polar front and a low center also pushed eastward over the southern Prairie Provinces.

The more southerly center deepened rapidly upon emerging on the central plains of Kansas on the 26th. The surface deepening took place without the assistance of any really cold air mass in the circulation. Pressure dropped on the 26th and 27th to all-time lows in the area: Texarkana 29.10″, Austin 29.27″, Tulsa 28.92″, Ft. Smith 29.01″, and Kansas City 28.84″.

The extreme deepening finally brought the polar front southward over the western Plains and blizzard conditions hit a wedged-shaped area covering central and western parts of the Dakotas, Nebraska, and Kansas and also over eastern Wyoming and Colorado. Seventeen inches of new snow fell at Pierre, South Dakota, and 14″ at Chadron, Nebraska. Winds of 60 mph whipped the snow across the open plains to fill road and railway cuts with tremendous drifts.

An interesting feature of the storm concerned the behavior of the warm front which ran through the center of a north-south trough connecting the low center over Canada with that in Kansas. This front remained almost stationary on the 26th and 27th over the middle Missouri Valley region, separating Arctic air to the west from much modified polar air to the east with a temperature differential of 25 degrees and more. The firmness of the warm front in its north-south position restricted the blizzard area to the western portion of the Plains for 48 hours until the 28th when the whole system receded eastward. Snow then spread over the North Central States but with greatly diminished intensity and much lower wind force.

January (*Continued from page 69*)

and lashed the Florida Straits and the Bahamas with near-hurricane winds of 70 mph. It was the worst winter storm in the 47-year history of the Miami Weather Bureau.

A second low latitude disturbance took form over northern Mexico on the 5th and, pulling copious moisture inland, dropped 6″ rain in the Lower Rio Grande and 7″ snow in west Texas and New Mexico. After turning northeastward in the central Gulf, the center cut across the northern Florida peninsula and speed up the Atlantic Coast as a tight-knit storm of rapidly increasing intensity. When the center crossed Nantucket Island on the 8th, a barometric pressure of 28.35″ was recorded—almost 0.50″ lower than ever recorded there in January and fairly close to the all-time low of 28.18″ in Hurricane Edna of September 1954. Heavy snows fell in a coastal belt from Virginia northward: 12″ in Virginia and Maryland, 15″ in southern New Jersey, and up to 20″ in a belt across southeastern New England and Maine.

Another storm moved from northeastern Mexico on the 12th and again caused heavy rains over east Texas and the Gulf States on the 12–13th. A secondary formed on the coast of Georgia, resulting in heavy rains over the Carolinas changing to snow in the interior from Pennsylvania to New England. Many northern ski resorts received up to 24″ of new snow for the first good skiing conditions of the season. The influence of the blocking high over Baffin Land stalled the further progress of this disturbance when it was off the New England coast. For five days it remained almost stationary in the Gulf of Maine area, causing five days of continuous precipitation over eastern New England.

A good rain-producing storm formed in Arkansas on the 21st. As it moved northeastward to Illinois, a heavy snow belt broke out from Missouri to Lake Michigan. Over 15″ fell in the Ozark Mountains of Missouri and 20″ at Kansas City, the latter's heaviest storm since the all-time high of 25″ in March 1912. Again the blocking high in northeast Canada caused the storm to side-slip eastward to northern Virginia where the center regenerated and pushed on to Nova Scotia, dropping 6″ of new snow over northern New York and New England.

Still another southern depression developed near Brownsville, Texas, on the 23rd, cut across Georgia on the 24th, and reached a position south-southeast of Cape Cod where it stalled as its predecessors had done. Its passage across Georgia was accompanied by a tornado at Cochran on the 24th, resulting in 12 injuries and $300,000 property damage. New England rainfall totals were swelled by 1–2 inches with rain falling on five consecutive days from the 25th through the 29th.

A final storm moved across the Gulf of Mexico on the 28–29th to cross southern Florida and move out into the Atlantic Ocean on a track further east than any previous January low. Moderate rains fell from Jacksonville to Hatteras. Its chief contribution to the winter season was to pull more cold air down from northern latitudes to prolong the Florida cold spell.

MILD WESTERN WINTER—While Florida froze, the Northwestern States, including the northern Plains, Rocky Mountain, Plateau, and Pacific areas, basked in the longest period of uninterrupted mildness of any winter of record. Temperatures in central Montana in January averaged 14 degrees above normal, the daily mean did not fall below normal on any day of the month, and no readings below 14° were registered at Great Falls, for example. At the latter point, it was the second warmest December and the second warmest January on record, the combination making the warmest December–January ever experienced.

The dividing line between the warm West and cold East, for the month as a whole, ran southwestward from Chicago to El Paso, Texas. Most of New England, too, experienced a very mild January due to the easterly circulation of maritime air there also; in eastern Maine the mercury averaged 10 degrees above the January normal.

The fast flow of westerlies in December carried over into January on the West Coast. A well-established Plateau high proved the dominant pressure configuration in the West; it held the polar front well north of the Canadian border and well east of its normal position, placing Montana and Wyoming and all to the west in the area of continued Pacific air masses. There were none of the usual winter invasions of polar air westward through the passes of the Rockies. In fact, the warm regime continued in Montana until 6 February when general zero readings broke the mild spell. Thereafter, the separating front was generally found along the Great Divide, where it continued to shield Idaho and the rest of the Northwest during the entire month of February. The three unseasonable winter months there made it one of the warmest on record.

Florida's Winter Weather

(*Continued from page 59*)

did not allow temperatures to reach seasonal levels for more than a day or two at a time at any place. Strong northerly winds accompanying each cold blast added to the general discomfort and caused considerable sand drifting in areas such as recently planted citrus groves and defoliated older groves. Rainfall associated with each cold air advance during January produced monthly totals about four times normal on the southern peninsula and about double on the northern peninsula. Snow, occurring mostly as flurries and melting as it fell, was reported as far south as southern Polk county (latitude about 27½°) on 8 January. On the night of 12–13 February, with the entire state covered by cold air and a low pressure system moving eastward through the Gulf to provide moist air overrunning, a general snow began falling in western and northern Florida. Snow accumulated and remained on the ground at nearly all reporting points north of latitude 30°. Snow, melting as it fell, was observed as far south as Gainesville (latitude 29° 38′). Figure — shows the general distribution of the reported snowfall—many west Florida points reported depths of 2 to 3 inches on the morning of the 13th. At several places this snow was the heaviest since 1899. At Jacksonville, the 1.5 inches measured occurred on the 59th anniversary of the only other recorded measurable amount—1.9 inches on 13 February 1899. The 2.8 inches at Tallahassee is the greatest amount ever measured since records began in 1886.

The warm weather which moved into the southeastern states during the last week of February was a long awaited sensation to nearly all Floridians. It was the first time since early January that temperatures remained close to seasonal averages for more than a day or two at a time. Most plant growth kept dormant by the cold burst forth and there was a general feeling of Spring not unlike that experienced annually in the more northern climes. Perhaps winter was over, but it had certainly left its reminders in frozen plant foliage and extraordinary home heating bills.

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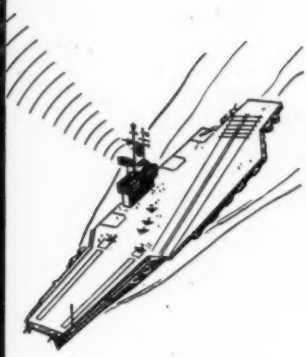

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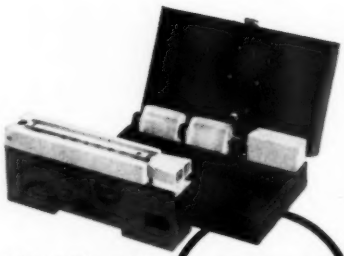

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